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The Relationship of Adverse Childhood Experiences to Adult Health: *Turning gold into lead**

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The Relationship of Adverse Childhood Experiences to Adult Health:
Turning gold into lead

The question of what determines adult health and well-being is important to all countries. The Adverse Childhood Experiences (ACE) Study[1] is a major American research project that poses the question of whether, and how, childhood experiences affect adult health decades later. This question is being answered with the ongoing collaboration of Robert Anda, MD at the Centers for Disease Control (CDC) and the cooperation of 17,421 adults at Kaiser Permanente's Department of Preventive Medicine in San Diego, California. Kaiser Permanente is a multispecialty, prepaid, private health insurance system or Health Maintenance Organization [HMO]. The findings from the ACE Study provide a remarkable insight into how we become what we are as individuals and as a nation. They are important medically, socially, and economically[2]. Indeed, they have given us reason to reconsider the very structure of primary care medical practice in America.

The ACE Study reveals a powerful relationship between our emotional experiences as children and our physical and mental health as adults, as well as the major causes of adult mortality in the United States. It documents the conversion of traumatic emotional experiences in childhood into organic disease later in life. How does this happen, this reverse alchemy, turning the gold of a newborn infant into the lead of a depressed, diseased adult? The Study makes it clear that time does *not* heal some of the adverse experiences we found so common in the childhoods of a large population of middle-aged, middle class Americans. One does not 'just get over' some things, not even fifty years later[3].

The Adverse Childhood Experiences Study is an outgrowth of observations we made in the mid 1980s in an obesity program that had a high dropout rate. The first of many unexpected discoveries was that the majority of the dropouts actually were successfully losing weight. Accidentally and to our surprise, we learned from detailed life interviews of 286 such individuals that childhood sexual abuse was remarkably common and, if present, always antedated the onset of their obesity. No one previously had sought this kind of medical information from them but many patients spoke of their conscious awareness of an association between abuse and obesity. Some told of instances where they had brought up their history of abuse only to have the information rejected by a physician as being in the distant past and hence of no relevance to current problems.

The counterintuitive aspect was that, for many people, obesity was not their problem; it was their protective *solution* to problems that previously had never been acknowledged to anyone. An early insight was the remark of a woman who was raped at age twenty-three and gained 105 pounds in the year subsequent: "Overweight is overlooked and that's the way I need to be." The contrast was striking between this statement and her desire to lose weight. Similarly, two men who were guards at the State Penitentiary became anxious after each losing over one hundred pounds. They said that they felt much safer going to work looking larger than life rather than normal size. In general, we found the simultaneous presence of strong opposing forces to be common in our obese patients. Many were driving with one foot on the brakes and one on the gas, wanting to lose weight but fearful of the change in social and sexual expectations that would be brought about by major weight loss.

Researchers at the Centers for Disease Control (CDC) recognized the importance of these clinical observations and helped design a large, epidemiologically sound study that would provide definitive proof of our findings and of their significance. The Adverse Childhood Experiences Study was carried out in Kaiser Permanente's Department of Preventive Medicine in San Diego. This was an ideal setting because for many years we had carried out detailed biomedical, psychological, and social (biopsychosocial) evaluations of over 58,000 adult Kaiser Health Plan members a year. Moreover, the patients were from a typical middle class American population. We asked 26,000 consecutive adults coming through the Department if they would be interested in helping us understand how childhood events might affect adult health status. Seventy-one percent agreed.

We asked these volunteers to help us study eight categories of childhood abuse and household dysfunction. The abuse categories were: recurrent physical abuse, recurrent severe emotional abuse, and contact sexual abuse. The five categories of household dysfunction were: growing up in a household where someone was in prison; where the mother was treated violently; with an alcoholic or a drug user; where someone was chronically depressed, mentally ill, or suicidal; and where at least one biological parent was lost to the patient during childhood – regardless of cause. An individual exposed to none of the categories had an ACE Score of 0; an individual exposed to any four had an ACE Score of 4, etc. In addition, a prospective arm of the Study is following the cohort for at least 5 years to compare distant childhood experiences against current Emergency Department use, doctor office visits, medication costs, hospitalization, and death.

Dr. Anda, my co-principal investigator at CDC, designed with great skill the massive data management and retrospective and prospective components of the Study. Because the average participant was 57 years old, we actually were measuring the effect of childhood experiences on adult health status a half-century later. The full text of our initial report is at http://www.meddevel.com/site.mash?left=/library.exe&m1=4&m2=1&right=/library.exe&action=search_form&search.mode=simple&site=AJPM&jcode=AMEPRE

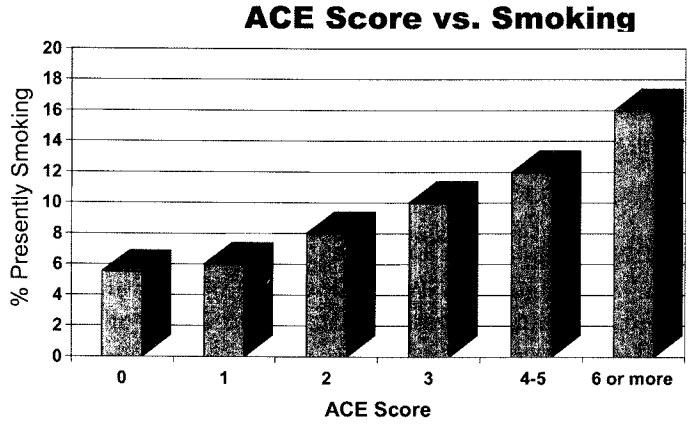
Our two most important findings are that these adverse childhood experiences:

- are vastly more common than recognized or acknowledged and
- have a powerful relation to adult health a half-century later.

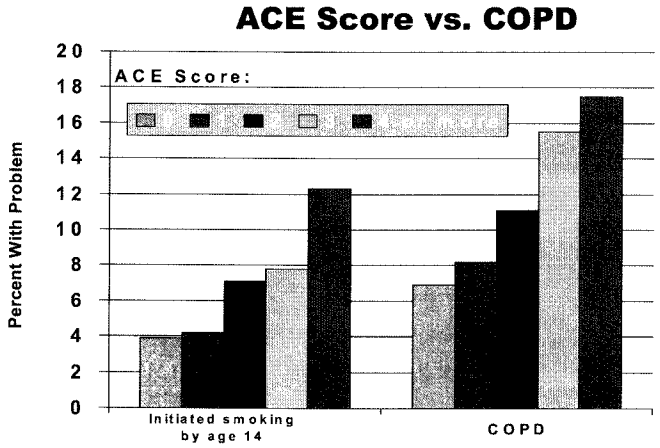
This combination makes them important to the nation's health and to medical practice. Slightly more than half of our middle-class population of Kaiser members experienced one or more of the categories of adverse childhood experience that we studied. One in four were exposed to two categories of adverse experience; one in 16 were exposed to four categories. Given an exposure to one category, there is 80% likelihood of exposure to another category. Of course, all this is well shielded by social taboos against seeking or obtaining this kind of information. Furthermore, one may miss the forest for the trees if one studies the categories individually. They do not occur in isolation; for instance, a child does not grow up with an alcoholic parent or with domestic violence in an otherwise supportive and well-functioning household. The question to ask is: How will these childhood experiences play out decades later in a doctor's office? To study that, we will categorize outcomes into organic disease and emotional disorder.

Organic disease:

We shall first look at the relationship of adverse childhood experiences to smoking[4]. Smoking underlies some of the most important causes of death in America; there has been a strong public health effort to eradicate smoking in California. In spite of initial success in significantly reducing the number of smokers, there has been no further net decrease in recent years although the efforts against smoking have continued. Because of this, smoking in the face of California's strong social pressures against it is often attributed to 'addiction'. The usual concept of tobacco addiction implies that it is attributable to characteristics that are intrinsic within the molecular structure of nicotine. However, we found that the higher the ACE Score, the greater the likelihood of current smoking. In other words, current smoking is strongly related in a progressive dose-response manner to what happened decades ago in childhood. Finding 'addiction' attributable to characteristics that are intrinsic in early life experiences challenges the conventional concept of addiction. The psychoactive benefits of nicotine are well established in the medical literature although they are little remembered. Are smoking and its related diseases the result of self-treatment of concealed problems that occurred in childhood?



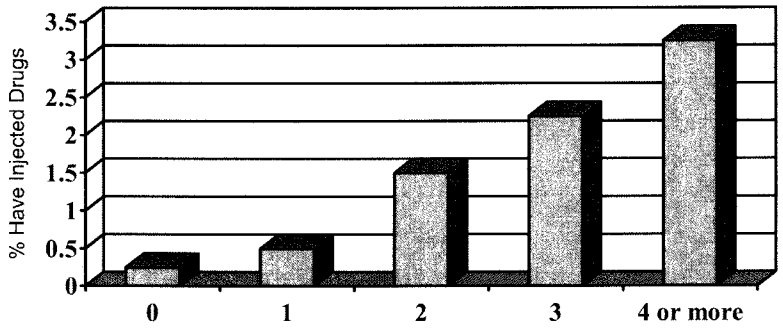
Chronic obstructive pulmonary disease (COPD) also has a strong relationship to the ACE Score, as does the early onset of regular smoking. A person with an ACE Score of 4 is 260% more likely to have COPD than is a person with an ACE Score of 0. This relationship has the same graded, dose-response effect that is present for *all* the associations we found. Moreover, all the relationships presented here have a p value of .001 or stronger.



When we compared hepatitis in ACE Score 0 patients with hepatitis in ACE Score 4 patients, there was a 240% increase in prevalence. A progressive dose response effect was present with every increase in the ACE Score. Similarly, with regard to sexually transmitted disease, comparison of the adjusted odds ratio for sexually transmitted disease in these same two groups showed a 250% increase at ACE Score 4 compared to ACE Score 0.

In the United States, intravenous drug use is a major public health problem with which little progress has been made. It is widely recognized as a cause of several life-threatening diseases. We found that the relationship of iv drug use to adverse childhood experiences is powerful and graded at every step; it provides a perfect dose-response curve.

ACE Score vs. Intravenous Drug Use

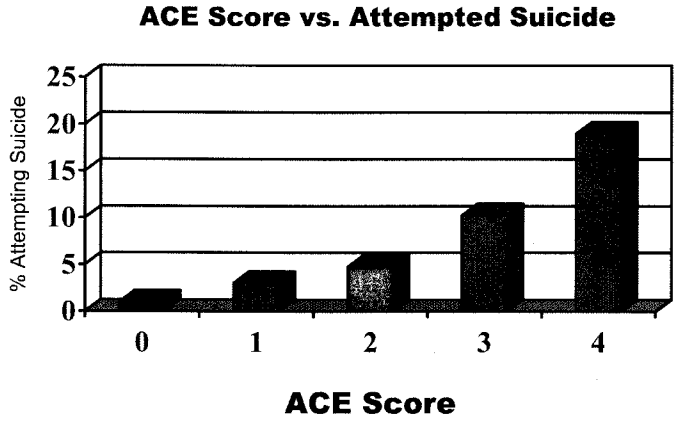


In Epidemiology, these results are almost unique in their magnitude. For example, a male child with an ACE Score of 6 has a 4,600% increase in the likelihood of later becoming an iv drug user when compared to a male child with an ACE Score of 0. Since no one injects heroin to get endocarditis or AIDS, why *is* it used? Might heroin be used for the relief of profound anguish dating back to childhood experiences? Might its psychoactive effects be the best coping device that an individual can find? Is intravenous drug use properly viewed as a personal *solution* to problems that are well concealed by social niceties and taboo? If so, is intravenous drug use a public health problem or a personal solution? Is it both? How often are public health problems personal solutions? Is drug abuse self-destructive or is it a desperate attempt at self-healing, albeit while accepting a significant future risk? This is an important point because primary prevention is far more difficult than anticipated. Is this because non-recognition of the *benefits* of health risk behaviors leads them to be viewed as irrational and as solely having damaging consequences? Does this major oversight leave us speaking in platitudes instead of understanding the causal basis of some of our intractable public health problems?

Emotional disorders:

When we looked at purely emotional outcomes like self-defined current depression or self-reported suicide attempts, we find equally powerful effects. For instance, we found that an

individual with an ACE Score of 4 or more was 460% more likely to be suffering from depression than an individual with an ACE Score of 0. Should one doubt the reliability of this, we found that there was a 1,220% increase in attempted suicide between these two groups. At higher ACE Scores, the prevalence of attempted suicide increases 30-51fold (3,000-5,100%)! Our article describing this staggering effect was published in a recent issue of the Journal of the American Medical Association[5]. Overall, using the technique of population attributable risk, we found that between two-thirds and 80% of all attempted suicides could be attributed to adverse childhood experiences.



In addition to these examples, we found many other measures of adult health have a strong, graded relationship to what happened in childhood: heart disease, fractures, diabetes, obesity, unintended pregnancy[6], sexually transmitted diseases[7], and alcoholism were more frequent. Occupational health and job performance worsened progressively as the ACE Score increased. Some of these results are yet to be published, as is all the data from the prospective arm of the Study that will relate adverse childhood experiences to medical care costs, disease, and death a half-century later.

Clearly, we have shown that adverse childhood experiences are common, destructive, and have an effect that often lasts for a lifetime. They are the most important determinant of the health and well-being of our nation. Unfortunately, these problems are painful to recognize and difficult to deal with. Most physicians would far rather deal with traditional organic disease. Certainly, it is easier to do so, but that approach also leads to troubling treatment failures and the frustration of expensive diagnostic quandaries where everything is ruled out but nothing is ruled in.

Our usual approach to many adult chronic diseases reminds one of the relationship of smoke to fire. For a person unfamiliar with fires, it would initially be tempting to treat the smoke because that is the most visible aspect of the problem. Fortunately, fire departments learned long ago to distinguish cause from effect; else, they would carry fans rather than water hoses to their work. What we have learned in the ACE Study represents the underlying fire in medical practice where we often treat symptoms rather than underlying causes.

If the treatment implications of what we found in the ACE Study are far-reaching, the prevention aspects are positively daunting. The very nature of the material is such as to make one uncomfortable. Why would one want to leave the relative comfort of traditional organic disease and enter this area of threatening uncertainty that none of us has been trained to deal with? And yet, literally as I am writing these words, I am interrupted to consult on a 70-year-old woman who is diabetic and hypertensive. The initial description given to me left out the fact that she is morbidly obese (one doesn't go out of one's way to identify what one can't handle). Review of her chart shows her to be chronically depressed, never married, and, because we routinely ask the question of 58,000 adults a year, to have been raped by her older brother six decades ago when she was ten. That brother molested her sister who is said also to be leading a troubled life.

We found that 22% of our Kaiser members were sexually abused as children. How does that affect a person later in life? How does it show up in the doctor's office? What does it mean that sexual abuse is never spoken of? Most of us initially are uncomfortable about obtaining or using such information; therefore we find it useful routinely to pose such questions to all patients by questionnaire. Our Yes response rates are quite high as the ACE Study indicates. We then ask patients acknowledging such experience, "*How did that affect you later in life*?" This question is easy to ask and is neither judgmental nor threatening to hear. It works well and you should remember to use it. It typically provides profoundly important information, and does so concisely. It often gives one a clear idea where to go with treatment.

What then is this woman's diagnosis? Is she just another hypertensive, diabetic old woman or is there more to the practice of medicine? Here is the way we conceptualized her problems:

Childhood sexual abuse
Chronic depression
Morbid obesity
Diabetes mellitus
Hypertension
Hyperlipidemia
Coronary artery disease
Macular degeneration
Psoriasis

This is not a comfortable diagnostic formulation because it points out that our attention is typically focused on tertiary consequences, far downstream. It reveals that the primary issues are well protected by social convention and taboo. It points out that we physicians have limited ourselves to the smallest part of the problem, that part where we are comfortable as mere prescribers of medication. Which diagnostic choice shall we make? Who shall make it? And, if not now, when?

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The Health and Social Impact of Growing Up With Adverse Childhood Experiences

The Human and Economic Costs of the Status Quo

Robert Anda, MD, MS

Co-Principal Investigator
Adverse Childhood Experiences (ACE) Study

The common stressful and traumatic exposures affecting the (neuro)development of our children are referred to herein as adverse childhood experiences (ACEs). Key among the constellation of these experiences is growing up in households affected by alcohol abuse; others include abuse (emotional, physical, sexual), neglect (emotional, physical), witnessing domestic violence, and growing up with substance abusing, mentally ill, parental discord, or crime in the home

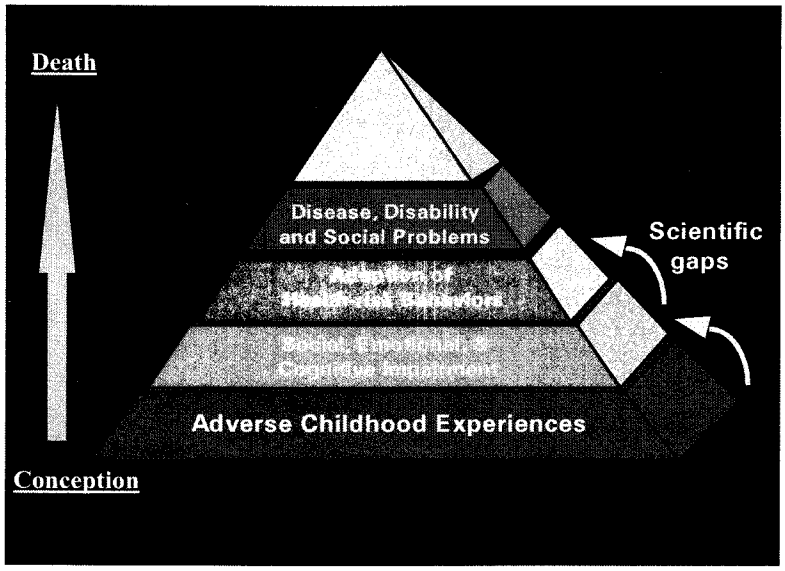
The information presented in this handout is in the public domain (reference list)[1-41] *and does not necessarily reflect the viewpoints of any organization(s) with which Dr. Anda may currently be, or has previously been affiliated.*

Executive Summary

The Adverse Childhood Experiences (ACE) Study is a decade-long and ongoing study designed to examine the childhood origins of many of our Nation's leading health and social problems. The Study represents collaboration between the Nation's leading prevention agency, the Centers for Disease Control and Prevention (CDC) and the Kaiser Health Plan's Department of Preventive Medicine in San Diego, CA.[1-41]

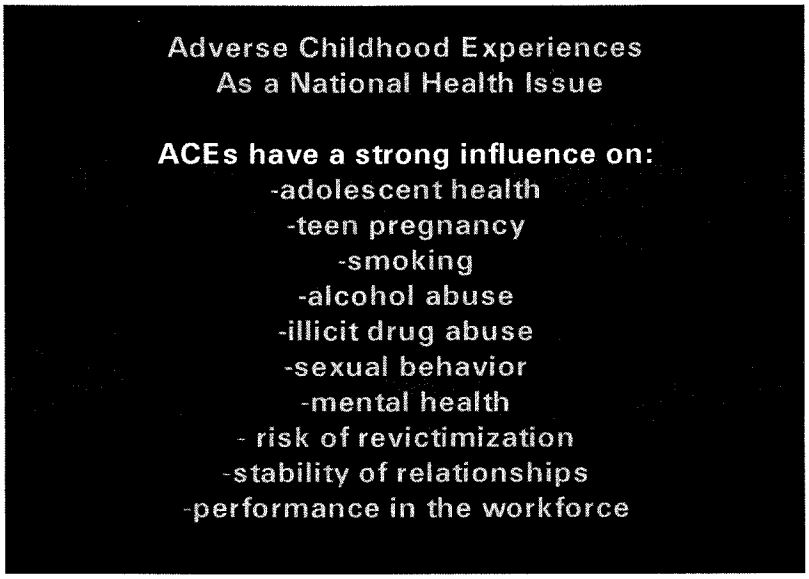
The key concept underlying the Study is that stressful or traumatic childhood experiences such as abuse, neglect, witnessing domestic violence, or growing up with alcohol or other substance abuse, mental illness, parental discord, or crime in the home (which we termed adverse childhood experiences—or ACEs) are a common pathway to social, emotional, and cognitive impairments that lead to increased risk of unhealthy behaviors, risk of violence or re-victimization, disease, disability and premature mortality (Figure A).[1-4,36,37] We now know from breakthroughs in neurobiology that ACEs disrupt neurodevelopment and can have lasting effects on brain structure and function—the biologic pathways that likely explain the strength of the findings from the ACE Study.[1]

Figure A.-Conceptual Framework for the ACE Study



We found that **ACEs are common**, even in a relatively well educated population of patients enrolled in one of the Nation's leading HMOs.[1,13,18,2336,37] More than 1 in 4 grew up with substance abuse and two-thirds had at least one ACE! More than 1 in 10 had 5 or more ACEs! And we found that **ACEs are highly interrelated**.[13] In order to assess the relationship of the ACEs to health and social problems we developed the **ACE Score,**[36.37] which is a count of the number of ACEs designed to assess **their cumulative impact on childhood development and therefore, their impact on a variety of health and social priorities in our country.**

What we found, using the ACE Score, stunned us even more. As the ACE Score increases so does the risk of numerous health and social problems throughout the lifespan (See Figure below). These problems are a "Who's Who?" list of problems that encompass the priorities of many agencies, public and private, that are working to prevent and treat a vast array of problems.[1-41] A summary of the problems strongly associated with the ACE Score follows.



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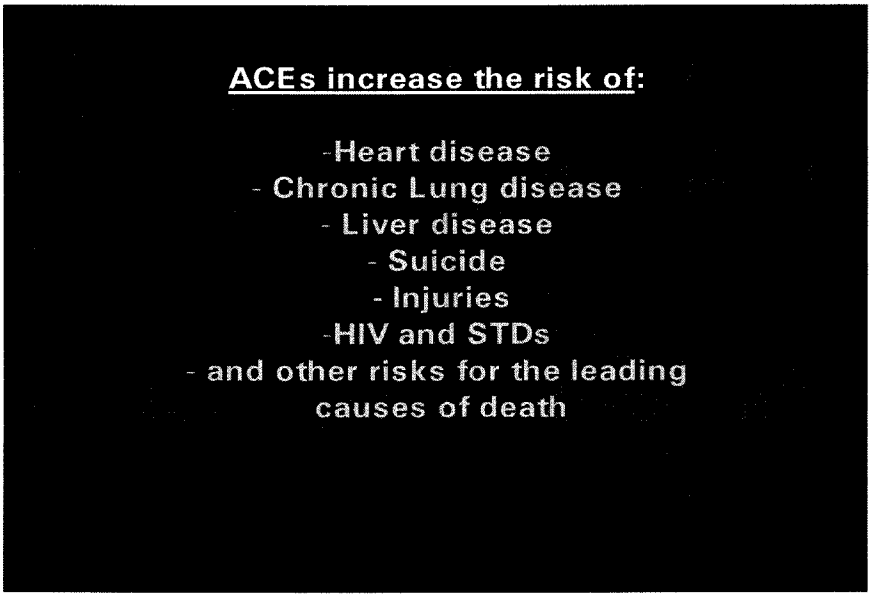


This vast array of problems that arise from ACEs calls for an integrated, rather than a separate or categorical perspective of the origins of health and social problems throughout the lifespan. This approach to growing up with ACEs, and to the consequences of exposure to them, may unify and improve our understanding of many seemingly unrelated health and social problems that tend to be identified and treated as categorically separate issues in Western society. Development of more integrated approaches will likely contribute to more meaningful diagnoses, improved treatment of affected persons, and better integration of research priorities, preventive and social services, and legal venues.[1,3]

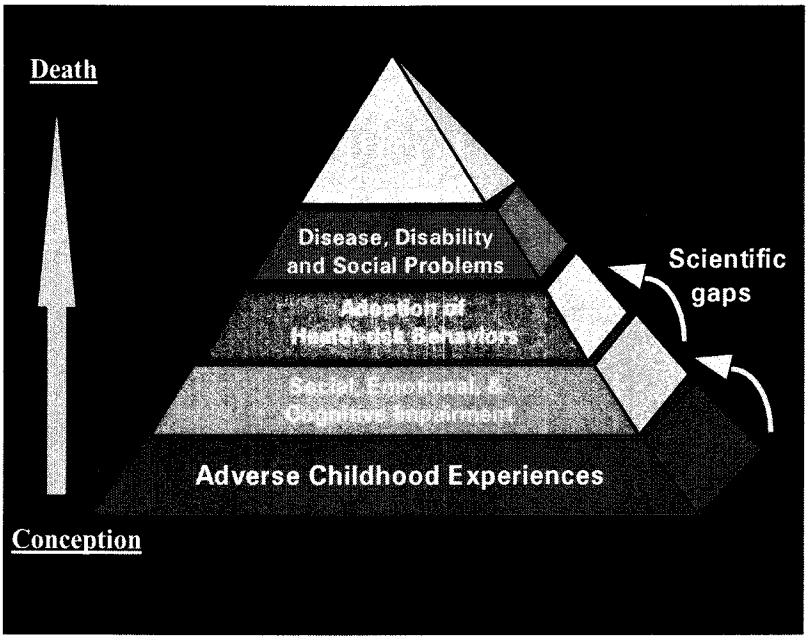
The ACE Study calls for an integrated approach to intervene early on children growing up being abused, neglected, witnessing domestic violence, or with substance abusing, mentally ill, or criminal household members. All of these childhood stressors are interrelated and usually co-occur in these homes. Prevention and treatment of one ACE frequently can mean that similar efforts are needed to treat multiple persons in affected families.

Introduction

This overview focuses on key findings from the ACE Study, published in peer-reviewed scientific journals, with an emphasis on how growing up with alcohol abuse and/or illicit drug use in the home becomes part of a spectrum of damaging childhood experiences. These childhood traumas lead to a wide array of negative health and social consequences.

The key concept behind the design of the ACE Study is that risk factors for health and social problems are not randomly distributed in the US population. We hypothesized that the experiences of childhood—specifically stressful or traumatic experiences that can negatively affect childhood development were fundamental underpinnings of the occurrence of these problems. We sought to fill the "scientific gaps" using a whole life model as depicted in Figure 1, below.[36,38]

Figure 1-Conceptual Framework for the ACE Study.



It is important to recognize that:

- Adverse childhood experiences (ACEs) are common.
- ACEs tend to occur in clusters, rather than single experiences.
- The cumulative impact of multiple exposures can be captured in an "ACE Score".
- The ACE score likely captures the cumulative (neuro)developmental consequences of traumatic stress.
- The ACE Score has a strong, graded relationship to numerous health, social, and behavioral problems throughout a person's lifespan
- These ACE-related problems tend to be co-morbid or co-occurring

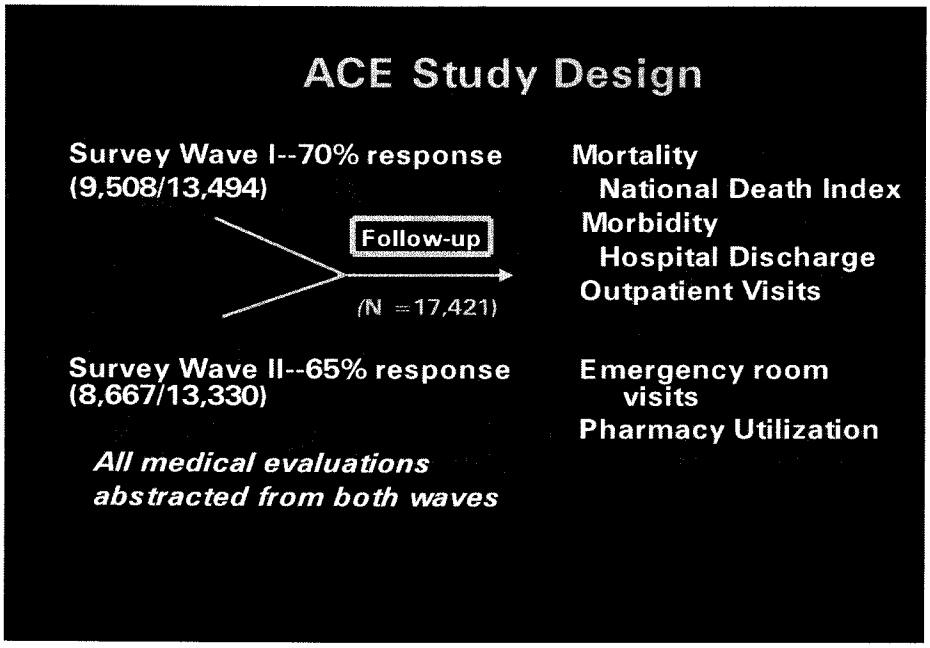
These points will be highlighted in the course of this review.

Design of the ACE Study

The Adverse Childhood Experiences (ACE) Study is the largest of its kind ever conducted both in size and scope of information collected. It examines the health and social effects of adverse childhood experiences throughout the lifespan and is an ongoing, decade-long collaboration between the Division of Adult and Community Health at the Centers for Disease Control and Prevention (CDC) and Kaiser Permanente's Department of Preventive Medicine in San Diego. The relationship of these experiences to a wide range of health and social problems throughout the lifespan has been, and continues to be, described by the ACE Study team.[1,36,38]

During two survey "waves" conducted during 1995 to 1997, 17,337 predominantly well educated, middle-class members of the Kaiser Permanente Medical Care Program in San Diego, California agreed to participate in the Study, as part of a comprehensive medical evaluation.[38] Prospective assessment of the relationships of ACEs to health care utilization, rates of pharmaceuticals prescribed, disease incidence, and causes of death is an ongoing focus of the Study (Figure 2).

Figure 2.—Design of the ACE Study



The ACE study population included 9,367 (54%) women and 7,970 (46%) men (total sample=17,337). Their mean age was 56 years. Seventy-five percent were white, 39% were college graduates, 36% had some college education, and 18% were high school graduates. Only 7% had not graduated from high school.[1,13]

The Study assessed 10 categories of stressful or traumatic childhood experiences.[13] The experiences chosen for study were based upon prior research that has shown them to have significant adverse health or social implications, and for which efforts in the public and private sector exist to reduce the frequency and consequences of their occurrence.

Prior research into the effects of childhood maltreatment and related experiences (including witnessing domestic violence) has tended to focus on only one or two categories of experience, such as physical or sexual abuse or domestic violence, and has generally focused on a limited range of outcomes. The ACE Study is unique not only because of its size, but because it was also designed to assess the relationships of a *broad range* of adverse childhood experiences (ACEs) to a *wide range* of health and social consequences.

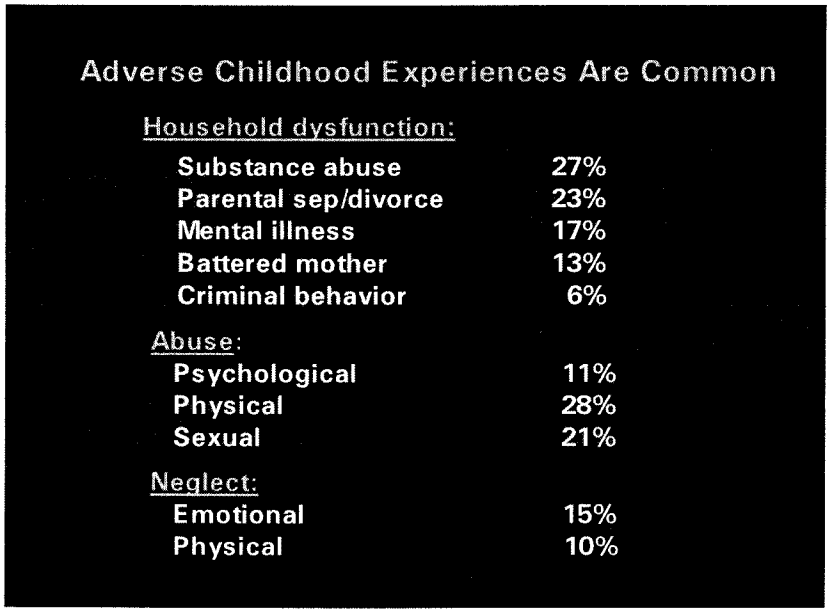
The 10 ACEs studied are as follows:

- Childhood abuse
  - -Emotional
  - -Physical
  - -Sexual
- Neglect
  - -Emotional
  - -Physical
- Growing up in a seriously dysfunctional household as evidenced by:
  - -Witnessing domestic violence
  - -Alcohol or other substance abuse in the home
  - - Mentally ill or suicidal household members
  - - Parental marital discord (as evidenced by separation or divorce)
  - - Crime in the home (as evidenced by having a household member imprisoned)

ACEs Are Common

The first important conclusion to be drawn is that adverse childhood experiences are very common, even in this well-educated, predominantly middle-class study sample (Figure 3, below).[1,13,36,38] Moreover, ACE Study estimates of the prevalence of childhood exposures to physical and sexual abuse are similar to population-based surveys. A national telephone survey of adults conducted by Finkelhor et al.[43] used similar criteria for childhood sexual abuse and determined that 16% of men and 27% of women had been sexually abused; in the ACE Study cohort 16% of men and 25% of women in our sample had experienced contact childhood sexual abuse. In our study, 30% of the men had been physically abused as boys; this closely parallels the 31% prevalence recently found in a similarly structured population-based study of Canadian men[44] The similarity of the estimates from the ACE Study to those of population-based studies suggests that our findings would be applicable in other settings.

Figure 3. – Prevalence of Adverse Childhood Experiences[1,13]



ACEs are Highly Interrelated

Probably as a result of the categorical approaches to the various ACEs, at the time that the ACE Study was designed relatively little was known about the co-occurrence of the 10 ACE categories chosen for study. Even less was known about the cumulative impact of multiple different exposures. Because initial analyses of the data showed that ACEs tended to be highly interrelated,[13,36,38] we described their co-occurrence in detail.[13] Figures 4 and 5 illustrate how growing up with alcohol abusing parents is strongly related to the risk of experiencing other categories of ACEs.[13]

Figure 4.-Alcohol Abuse and the Risk of Childhood Abuse

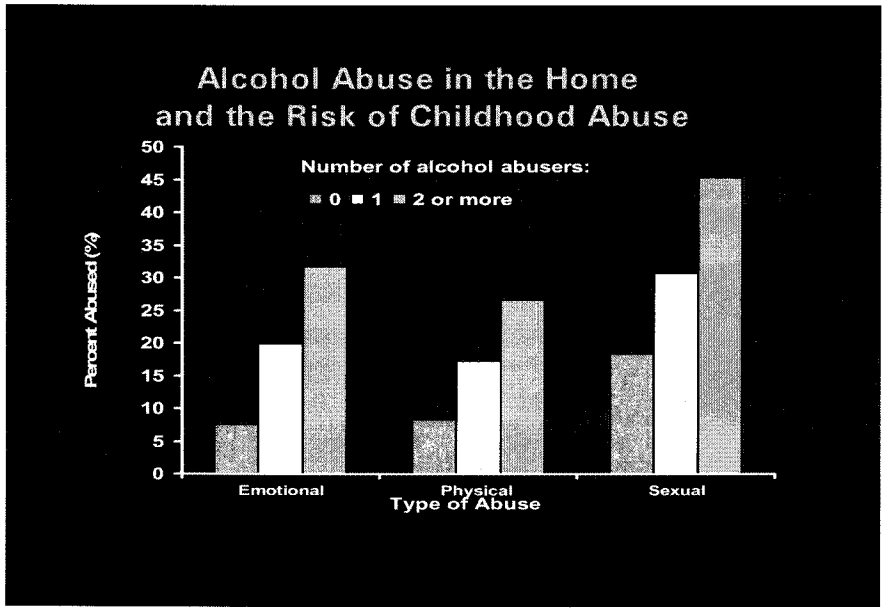
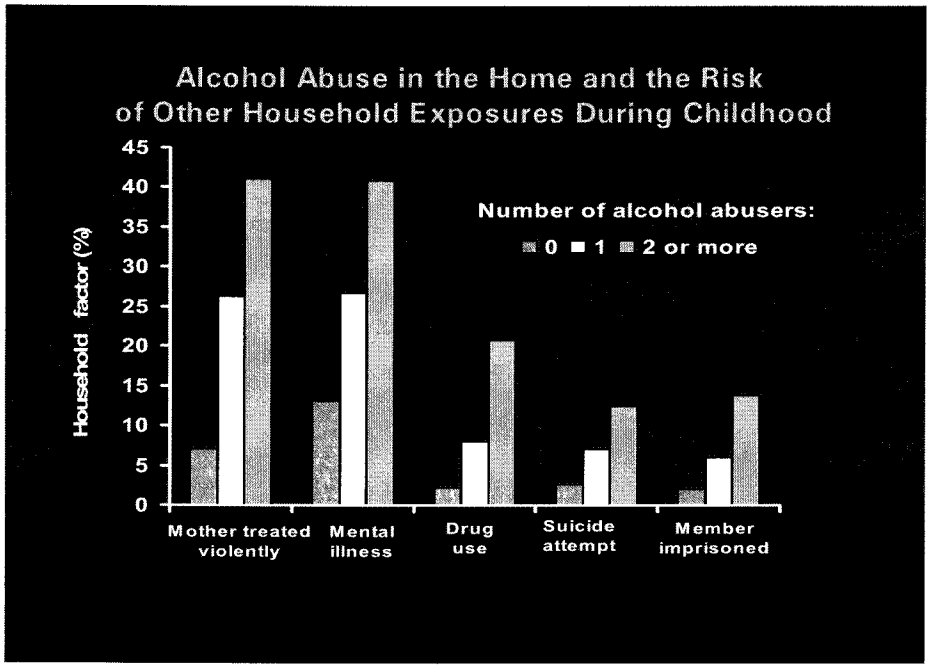


Figure 5.-Alcohol Abuse in the Home and the Risk of Other ACEs



The Occurrence of One ACE Should Evoke a Search for Others

Table 1 shows the probability (%) of experiencing additional ACEs based upon the occurrence of each individual category of ACE.[5] In the case of persons who had grown up with household substance abuse, 81% reported at least one additional ACE and the majority had experienced 2 or more ACES. In the entire study population, 81%-98% of respondents who had experienced one ACE reported at least one additional category of ACE (median: 87%).[13]

Table 1.-Prevalence of Each Category of Adverse Childhood Experience and Likelihood of Other ACEs[13]

ACE category	Additional ACEs (%)						
	0	≥1	≥2	≥3	≥4	≥5	≥6
Abuse							
Emotional	2	98	90	77	62	42	25
Physical	17	83	64	46	32	20	12
Sexual	22	78	58	42	29	19	12
Neglect							
Emotional	7	93	79	63	47	32	19
Physical	11	89	75	61	50	37	24
Household dysfunction							
Parental separation or divorce	18	82	61	43	30	19	12
Household substance abuse	19	81	60	41	29	18	11
Household mental illness	16	84	65	48	34	21	13
Battered Mother	5	95	82	64	48	32	20
Crime	10	90	74	56	43	30	23
Median	13.5	86.5	69.5	52.0	38.5	25.0	16.0
Range	2-22	78-98	58-90	41-77	29-62	18-42	11-25

Thus, **ACEs are highly interrelated; the occurrence of one should evoke a search for others. In addition, this interrelatedness made assessment of the effects of *single ACEs* on health and social well-being illogical.**

The ACE Score

Because adverse childhood experiences are highly interrelated, we developed the ACE Score as a measure of the cumulative exposure to abuse, neglect, alcohol and other substance abuse, domestic violence and other forms of serious household dysfunction.[1,13,36,38] Exposure to any ACE category (Table 1, above) counted as one "point" on the Score; the number of *categories* of adverse experience were then summed. The ACE Score therefore ranged from 0 to 10. The ACE Score indicates, in summary form, the amount of exposure to the ten categories of adverse experience in childhood and adolescence. There was no further scoring within a category. Statistical analysis has confirmed that the observed number of respondents with high ACE scores was notably higher than the expected number under the assumption of independence of ACEs ($p<.0001$).[13] The prevalence of the ACE Scores by gender is presented in Table 4.[13] Two-thirds of participants reported at least one category of ACE. One in ten people had an ACE Score of 5 or more; higher ACE Scores are

somewhat more common in women. Even in this well educated population of HMO patients, less than one-third had an ACE Score of 0! Or from the perspective of a provider of health or social services in this population 1 or 2 out of every ten adults seen have an ACE Score of 5 or more!

Table 4. Prevalence of the ACE Score by Gender

	Prevalence (%)		
	Women	Men	Total
ACE Score			
0	31.3	34.2	32.7
1	24.2	27.3	25.6
2	14.8	16.4	15.5
3	10.4	9.3	9.9
4	6.8	4.8	5.9
≥5	12.5	8.0	10.5

The ACE Score Has a Graded Relationship to Numerous Health and Social Outcomes: An Indicator of the Effects of Cumulative Stress on (Neuro)Development

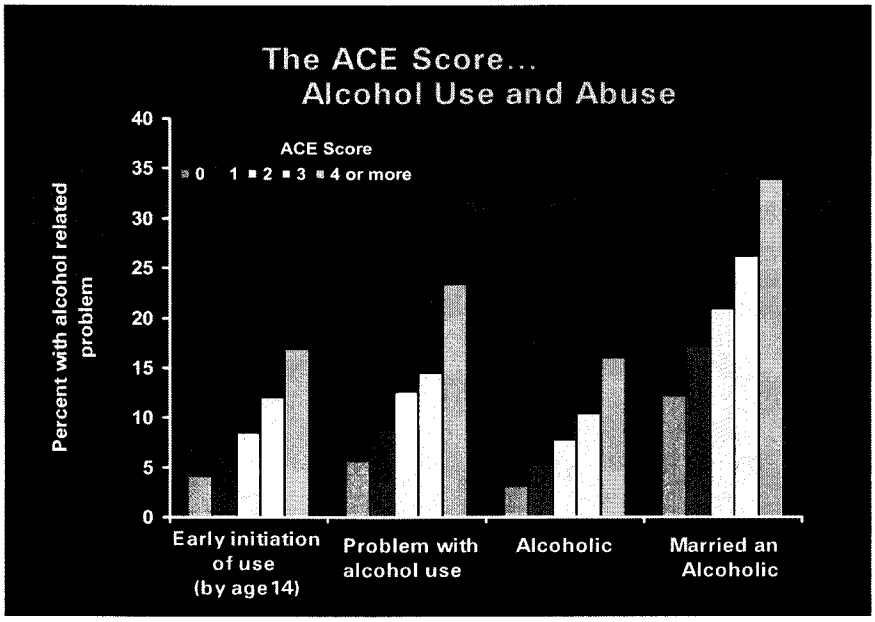
The relationship of the ACE Score to a wide range of health, emotional, and social outcomes has been described.[1-41] It is noteworthy that the use of the ACE Score as a measure of the cumulative exposure to traumatic stress during childhood is consistent with more recent understanding, from the neurosciences[1,45] of the effects of traumatic stress on neurodevelopment. Neuroscientists have linked childhood maltreatment--using experimental animal models as well as case-control studies in humans--to long-term changes in brain structure and function, involving several inter-connected brain regions including the prefrontal cortex, hippocampus, amygdala, corpus callosum, and cerebellum.[46-51] Early stress is also associated with lasting alterations in stress-responsive neurobiological systems, including the hypothalamic-pituitary-adrenal axis and monoamine neurotransmitter systems; these lasting effects on the developing brain would be expected to affect numerous human functions into adulthood including (but not limited to) emotional regulation, somatic signal processing (body sensations), substance abuse, sexuality, memory, arousal, and aggression.[52-57]

Numerous publications have documented a graded or "dose-response" relationship between the number of categories of ACEs (ACE Score) and a wide variety of health and social problems of national importance.[1-41] I consider the "dose-response" findings quite literally; the ACE Score appears to capture cumulative exposure of the developing brain to the activated stress response, which is the pathway by which ACEs exert their neurobiological impact. This "dose response" relationship is evident in the figures that follow in the next section; as the ACE Score goes up, so does the risk of problems from adolescence to adulthood.

Relationship of the ACE Score to Alcohol Use and Abuse

One of the strongest relationships seen was between the ACE score and alcohol use and abuse (Figure 5).[2,25] Given recent research indicating the negative impact of alcohol use on neurodevelopment of adolescents, the relationship of ACEs to early initiation of alcohol use is particularly worrisome. The negative health and social consequences of alcohol abuse and alcoholism constitute a major public health problem—and ACEs have a particularly strong association with alcohol abuse. In addition, it is notable that the perpetuation of the cycle of alcohol abuse appears to be tightly interwoven with the number of ACEs, including marriage to an alcoholic.

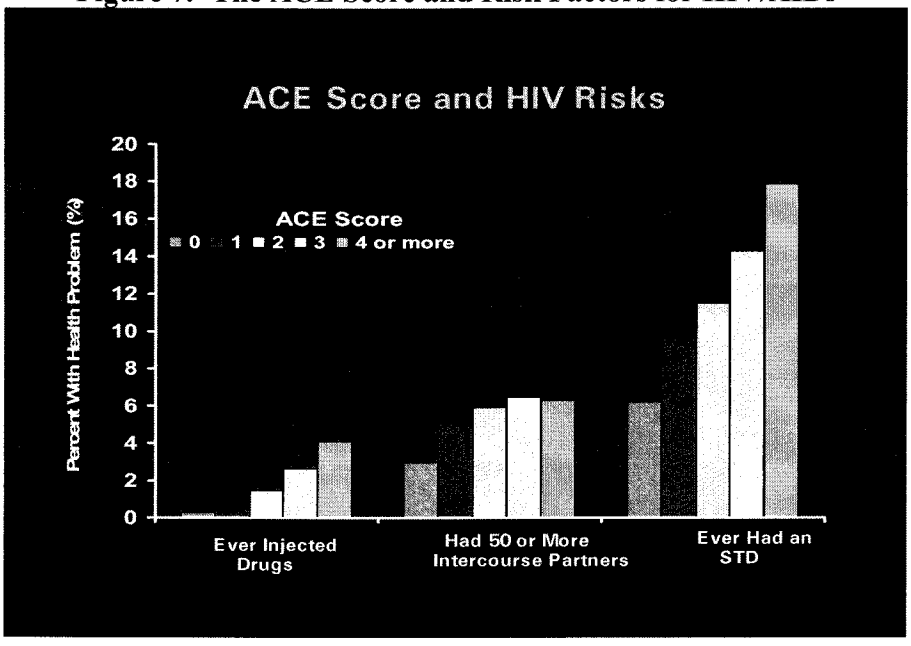
Figure 6.- Relationship of the ACE Score to Alcohol Use and Abuse



The ACE Score and Risk Factors for HIV/AIDs

The risk factors for transmission of the Human Immunodeficiency Virus (HIV), the causative agent of the AIDS epidemic are now well known. What appears to be less well known is that ACEs are a major hidden "engine" underlying these preventable risk factors for the transmission of HIV (Figure 6). Injected drug use, promiscuity (defined as having had 50 or more lifetime intercourse partners), and ever having a sexually transmitted disease (including AIDs), all increase dramatically as the ACE Score increases.[11,16,29,35,38]

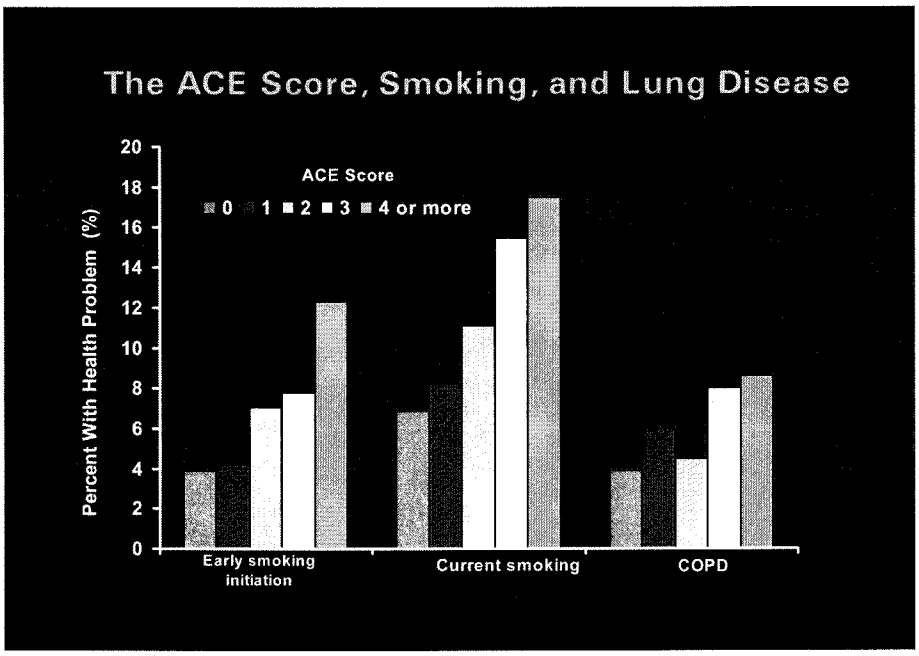
Figure 7.- The ACE Score and Risk Factors for HIV/AIDs



The ACE Score, Smoking, and Chronic Obstructive Pulmonary Disease

Cigarette smoking is the leading cause of preventable morbidity and mortality in the United States. Unfortunately, as with initiation of alcohol use, ACEs increase the likelihood of early smoking initiation.[36] Moreover, ACEs lead to continued smoking and the risk of Chronic Obstructive Pulmonary Disease (COPD; one of the 10 leading causes of death in the US).[36,38]

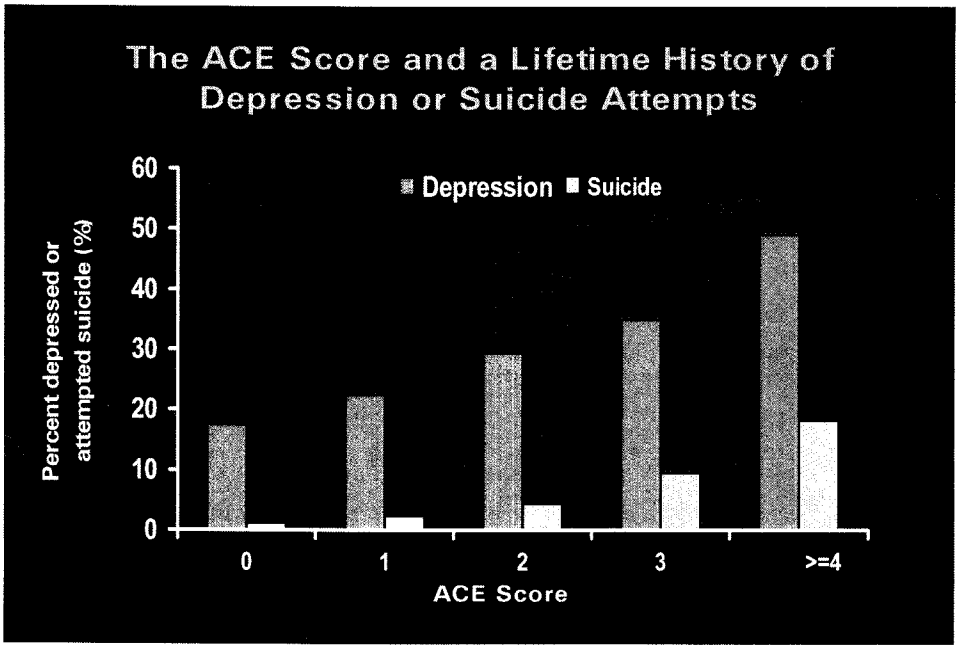
Figure 8.--Relationship of the ACE Score to Smoking and COPD



ACEs, Depression, and Suicide Attempts (Figure 8)

Depression is now recognized to be a leading cause of disability worldwide, and ACEs bear a strong relationship to this common mental health problem; the relationship is equally strong for both men and women.[15] Suicide is a leading cause of death in the US with a "bimodal" age pattern of attempts—one peak in adolescence and one in middle age. Here also, ACEs have a powerful graded relationship to the risk of suicide attempts; this holds for attempts by men and women and attempts during adolescence or adulthood.[34]

Figure 9, - Relationship of the ACE Score to Depression and Suicide Attempts



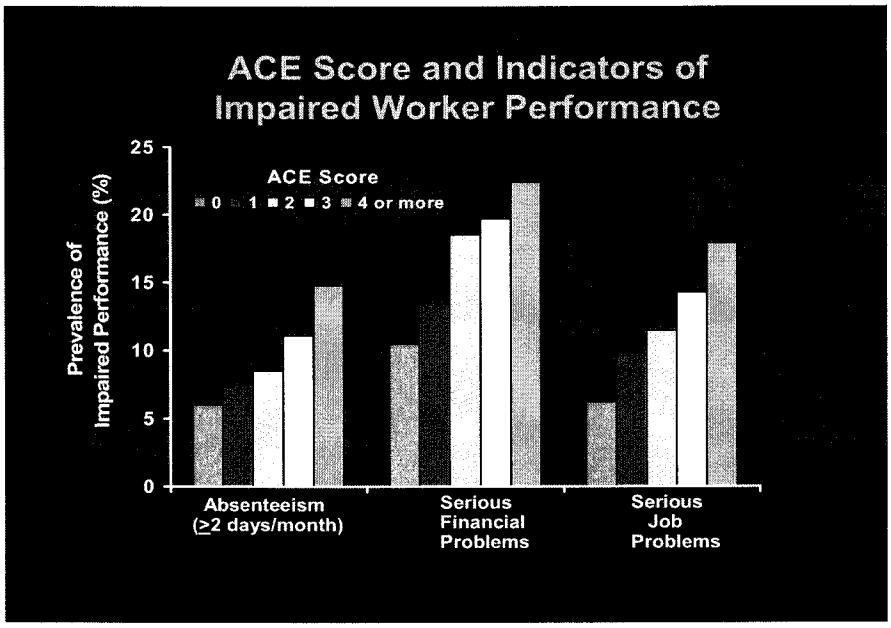
By now it should be obvious that the long term human costs of ACEs are enormous and that the problems associated with these problems also translate into costs of health care, disability, and social services. Now, let's turn to two examples where the costs—in economic terms—are most obvious.

ACEs Affect Worker Performance

Inasmuch as ACEs affect the health and well-being of the workforce, they are a hidden drain on profitability for corporate America. The human and economic costs of the long-term effects of adverse childhood experiences on the workforce are likely major and merit attention by the business community in concert with the modern practice of medicine and public health. Recent studies estimated annual costs as high as $28 billion for chronic back pain for US businesses,[58] $30-$44 billion for depression and related absenteeism, reduced productivity, and medical expenses,[59] and $246 billion for chemical dependency in the workforce.[60] These massive losses occur despite safety programs and the most expensive medical care system in the world.[61] If these areas are indeed related to the performance of the workforce, profitability of businesses and even national productivity are likely to be affected as well.

Absenteeism, financial problems, and self-reported problems on the job are all indicators of impaired productivity that are expensive and are also indicators of ACE related problems such as alcohol abuse, chronic pain, mental health disorders, and others. Figure 9 displays the relationship of ACEs to these indicators of reduced worker productivity.[10]

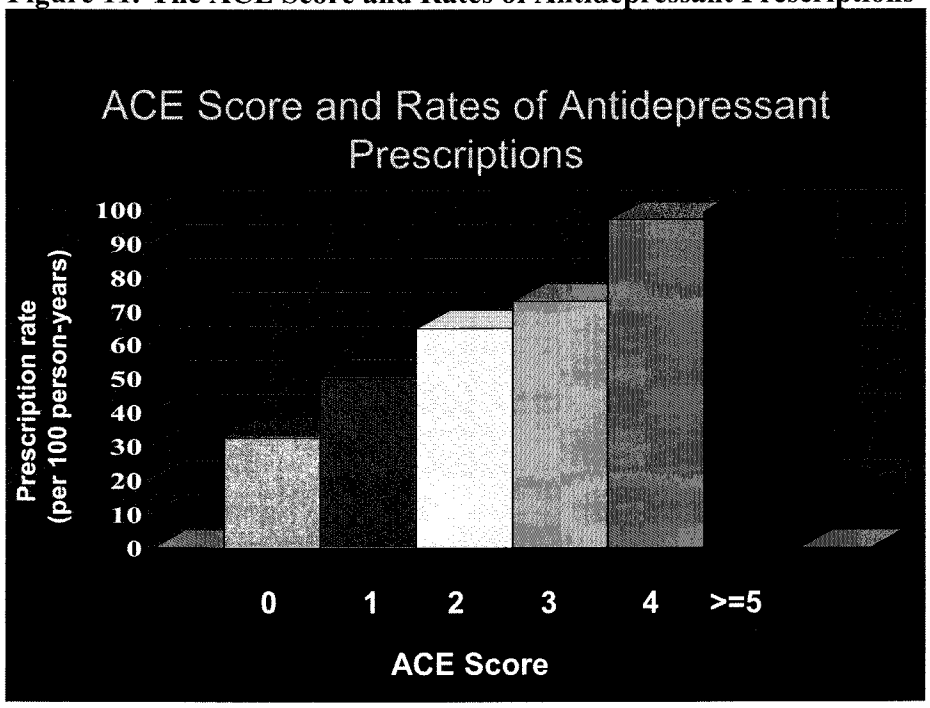
Figure 10.-ACEs and Indicators of Impaired Worker Performance



ACEs and Direct Health Care Costs—Prescription Pharmaceuticals

Nearly $180 billion were spent on prescription drugs in the United States in 2003. This represents approximately 11% of total national health expenditures and was more than four times the amount spent in 1990.[62] One of the most rapidly rising set of prescribed drugs is antidepressants; how do ACEs affect their use?

Figure 11.-The ACE Score and Rates of Antidepressant Prescriptions[4]



Given the results of the ACE Study, what are the human, social, and economic costs of the high prevalence, interrelatedness, and long-term consequences of Adverse Childhood Experiences?

Implications

The effects of ACEs are long-term, powerful, cumulative, and likely to be invisible to health care providers, educators, social service organizations, and policy makers because the linkage between cause and effect is concealed by time, the inability to "see" the process of neurodevelopment, and because effects of the original traumatic insults may not become manifest until much later in life.[1,3,36,38] When a child is wounded, the pain and negative long-term effects reverberate as an echo of the lives of people they grew up with—and then they grow up, at risk for taking on the same characteristics and behaviors—thereby sustaining the cycle of abuse, neglect, violence and substance abuse, and mental illness. For example, ACEs greatly increase the risk of adult alcohol abuse or marriage to an alcoholic,[25] perpetuating the adversities and their consequences.[28] Thus, growing up with alcohol abuse contributes to many of the leading chronic health and social problems in the United States.

Information from the ACE Study suggests that traumatic stressors during childhood and adolescence represent a common pathway to a variety of important long-term behavioral, health, and social problems (see Appendix, page 22). Thus, an integrated rather than a separate or categorical, perspective on the origins of health and social problems throughout the lifespan is needed. This approach to alcohol abuse and related ACEs, and to the consequences of exposure to them, may unify and improve our understanding of many seemingly unrelated health and social problems that tend to be identified and treated as categorically separate issues in Western culture.

The ACE Score appears to be a robust of the cumulative, lifetime impact of traumatic stress on neurodevelopment in childhood. Stressful and traumatic childhood and adolescent experiences literally become "biology" affecting brain structure and function (as well as endocrine, immune, and other biologic functions) thus leading to persistent effects. Until now, these persistent effects were "hidden" from the view of both neuroscientists and public health researchers. **This is no longer the case. In fact, with this information comes *the responsibility to use it.*[40]**

These links between childhood experience and adult health and social function have significant implications for health and social services. We found that adults who reported any single category of adverse childhood experience were likely to have suffered multiple other categories during childhood. Therefore, assessment of exposure to other ACEs is important when working with children or adults identified as having had any single type of ACE. Children experiencing alcohol abuse in the home should be screened for other types of maltreatment and traumatic stressors—and vice versa! This information, if routinely gathered will likely contribute to more meaningful diagnoses, earlier and improved treatment of exposed *children and their caretakers*, and better integration of prevention, social services, and legal venues.

Facing the high prevalence and interrelatedness of ACEs is going to be tough. Categorical approaches to the individual ACEs as well as the health and social problems strongly related to them tend to be "siloed". However, the professions, research priorities, organizations, and resources that are necessary to healing frequently exist in "silos"--separate, often competitive rather than collaborative, entities, each preserving and advancing the resources and work that is historically "theirs". While this is understandable, to succeed, we must make this "ours", a team effort that reaches beyond traditional boundaries and borders.

Prevention and remediation of our nation's leading health and social problems are likely to benefit from integrated approaches that incorporate information about their common origins in the enduring neurodevelopmental consequences of growing up with alcohol abuse and related adverse experiences during childhood.

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Appendix—Detailed Listing of Health and Social Problems Shown to Have a Graded Relationship to the ACE Score.*

Type of Problem	Outcomes Associated with Adverse Childhood Experiences
Prevalent Diseases	Ischemic heart disease[14,28] cancer,[38] chronic lung disease,[38] skeletal fractures,[38] sexually transmitted diseases,[35,38] and liver disease[11,38]
Risk Factors for Common Diseases/Poor Health	Smoking,[1,36,38] alcohol abuse,[1,2,11,19,25,38] promiscuity,[1,29,35,38] obesity,[26,38] illicit drug use,[1,16,38] injected drug use,[1,26,38] multiple somatic symptoms,[1] poor self-rated health,[38] high perceived risk of AIDS[29]
Poor Mental Health	Depressive disorders,[1,14,15,36,38] anxiety,[1] hallucinations,[1,8] panic reactions,[1] sleep disturbances,[1] memory disturbances,[1,31] poor anger control,[1] risk of perpetrating or being a victim of domestic violence[1,17]
Sexual and Reproductive Health	Early age at first intercourse,[1,38] sexual dissatisfaction,[1] teen pregnancy,[9] unintended pregnancy,[27] teen paternity,[27,32] fetal death[9]
General Health and Social Problems	High perceived stress,[1] difficulty with job performance,[10] relationship problems,[10] marriage to an alcoholic[25]

* A complete bibliography of ACE Study publications listed by topic area is available online at http://www.cdc.gov/nccdphp/ace/

intermountain
restoring hope for children

April 19, 2011

Testimony to support SJ130 to request an interim study of ways to reduce childhood health trauma and its long-term effect on children

Mr. Chairman and Members of the Committee:

Thank you for your time this morning. My name is Kimberly Gardner. I am a Licensed Clinical Social Worker and a Licensed Addictions Counselor. I am a Child and Family therapist and am the Clinical Manager of Intermountain's Community Outpatient Services here in Helena. I have worked in the field of children's mental health since 1987. My husband and I are also respite foster parents for high needs kids in foster care.

As a society, we already know globally, and many of us personally, the effects of trauma. Our moral code and conscience tells us that physical, sexual and emotional abuse are bad for kids and families. We know the outcome of untreated alcohol and drug abuse. None of us take pride in the high ranking we have nationally with our suicide statistics in children and adults. Many of us have observed the dismal quality of life in a home where the is chronic depression or mental illness in a parent. We've seen and heard horrifying signs of prevent domestic violence. We can all guess the likely outcome of a child whose parent is absent because of prison, addiction or abandonment. Ask any 3rd grade teacher who he or she is worried about and they'll point out the kids without adequate nurturing and parenting.

There is a huge amount of research that tells us that trauma abuse and neglect in a child's life results in permanent changes in the way a child thinks, feels and acts that is different than kids who have not had those experiences.

1. We need a practical, effective and affordable strategy to prevent trauma, abuse and neglect wherever possible and to address it when we haven't prevented it.

We have a lot of evidence already that we're not doing very well in MT with our current strategies. I have clinical oversight over Intermountain's School Based Mental Health Services and our in-home therapeutic family care services. We provide mental health services for kids in the community who have emotional or behavioral problems. We currently serve an average of 150 kids in this tri-county area. Of those children, nearly two-thirds are already placed in homes other than their birth parent's home. Some are in relatives homes, some in foster homes, group homes or shelters or adoptive homes.

At Intermountain, we know that kids with trauma and their families need a different kind of care. Those kids are far more likely to develop mental illness and have chronic life time problems and mental illness as adults. We have to do better.

If a child is removed from their family because of abuse or neglect, there's a very high likelihood that that child will have multiple out-of-home placements, in multiple homes and will struggle emotionally, physically and academically. At Intermountain, we try to stop that cycle.

We have a unique model that walks both the child and the family through the process of understanding and healing their abuse as well as learning to live together. We work to help the child and family know what to expect and how to prevent the placement from disrupting - which results in yet another placement. If the child is living with his or her biological parents, we work with them to understand how trauma, abuse or neglect affects a developing brain and how to parent differently.

2. One thing we do know ~ If Nothing Changes - Nothing Changes.

In MT we've developed many programs and systems to try to deal with the problem. Many of our own communities, agencies and schools have services that try to prevent and treat child trauma, abuse and neglect. Some services, like ours at Intermountain, are specialized and are very successful and some are not producing very good results at all.

What we do know is that it's a little like the "Starfish Story". For every child and family that stops the cycle we're excited for and proud of them.

However - we know that things are getting worse and we need a state strategy to unify all of our efforts. We can learn from the research that is out there. We can look at what has already been learned and apply it to our own state in a way that makes sense.

3. We have what it takes to be successful in preventing trauma, abuse and neglect in most of the cases - - and to treat it and stop the cycle when we have not prevented it.

Most of us remember when littering was common and tolerated by our stated. A few people made a decision that our natural resources were too precious to waste and jeopardize that way. Over a short period of time we all took responsibility for the problem and littering stopped.

A few years ago we saw that meth use was killing our kids, families and our communities. Again, a few people made the decision to intervene and we now have one of the most informed states on this issue in the country. We're addressing it at every level in this state - from pregnant women to adult programs.

What if we took this issue and made a decision to be the most informed state we could be?

What if we made the decision to develop a statewide strategy to do better - to provide the best prevention and the best responses to trauma, abuse and neglect?

The first step would be to ask the question that this study would ask. What is going on in MT - what is the truth about trauma abuse and neglect and what is working and not working.

That would be a very brave question because we know that we want things to be better for kids, families and communities.

The next step would be to develop a statewide strategy that is both practical and effective.

We'd have to stop looking the other way - as we often do in Montana - and admit that what we're doing isn't working. Children's mental illness isn't visible - we'll have to look very closely to see the signs - and they are everywhere.

We'll have to be assertive with each other and say that our children's well being is everyone's business!

So - let's create a life worth living for every citizen in Montana. I think we all want to live a life worth living and to have our next generation have a better life than ours. That's what I hope for my clients and my own kids.

We're at a critical state right now in Montana. We're paying a terrible price financially and culturally right now.

Knowledge is power. I'm leaving you with several articles as an example of the research that is already available to you. Please feel free to contact me if you would like to know more. I know I can speak for Intermountain and tell you that anyone at Intermountain would be glad to help you learn what you'll need to know.

Thank you,

Kim Gardner

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About The Adverse Childhood Experiences Study

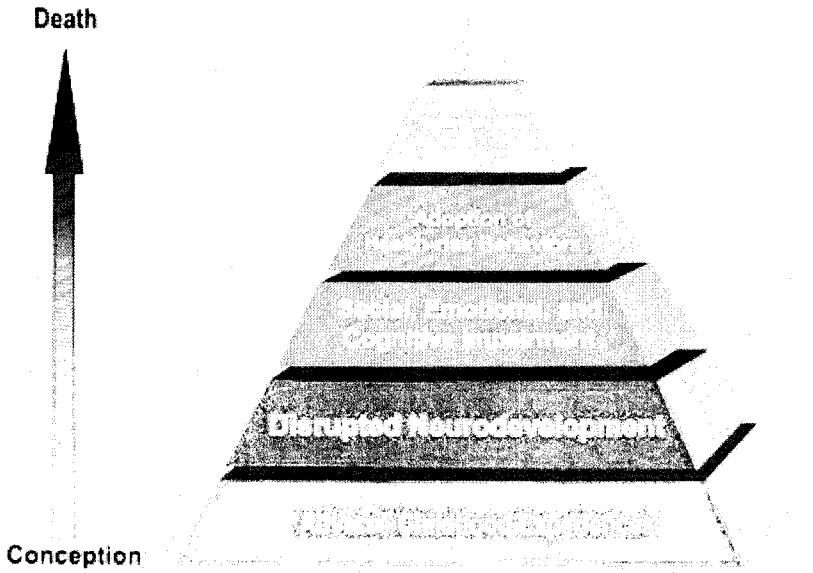
Why is it important to know about the Adverse Childhood Experiences Study?

Because it provides compelling evidence that:

- ACEs are surprisingly common.
- They happen even in "the best of families".
- They have long-term, damaging consequences.

The pyramid below helps visualize the process by which harsh experiences such as abuse, neglect, and loss of birth parent(s) during childhood result in health problems in adulthood.

For deeper insight into the definition, frequency, presence, and consequences of Adverse Childhood Experiences, read the downloadable documents available at our ACE-related Publications page.



Mechanisms by Which Adverse Childhood Experiences Influence Health and Well-being Throughout the Lifespan

"The question of what determines adult health and well being is important to all countries..."

"The question of what determines adult health and well-being is important to all countries. The Adverse Childhood Experiences (ACE) Study(1) is a major

American research project that poses the question of whether, and how, childhood experiences affect adult health decades later. This question is being answered with the ongoing collaboration of Robert Anda, MD at the Centers for Disease Control (CDC) and the cooperation of 17,421 adults at Kaiser Permanente's Department of Preventive Medicine in San Diego, California. Kaiser Permanente is a multispecialty, prepaid, private health insurance system or Health Maintenance Organization [HMO]. The findings from the ACE Study provide a remarkable insight into how we become what we are as individuals and as a nation. They are important medically, socially, and economically(2). Indeed, they have given us reason to reconsider the very structure of primary care medical practice in America.

The ACE Study reveals a powerful relationship between our emotional experiences as children and our physical and mental health as adults, as well as the major causes of adult mortality in the United States. It documents the conversion of traumatic emotional experiences in childhood into organic disease later in life. How does this happen, this reverse alchemy, turning the gold of a newborn infant into the lead of a depressed, diseased adult? The Study makes it clear that time does not heal some of the adverse experiences we found so common in the childhoods of a large population of middle-aged, middle class Americans. One does not 'just get over' some things, not even fifty years later(3)."(4)

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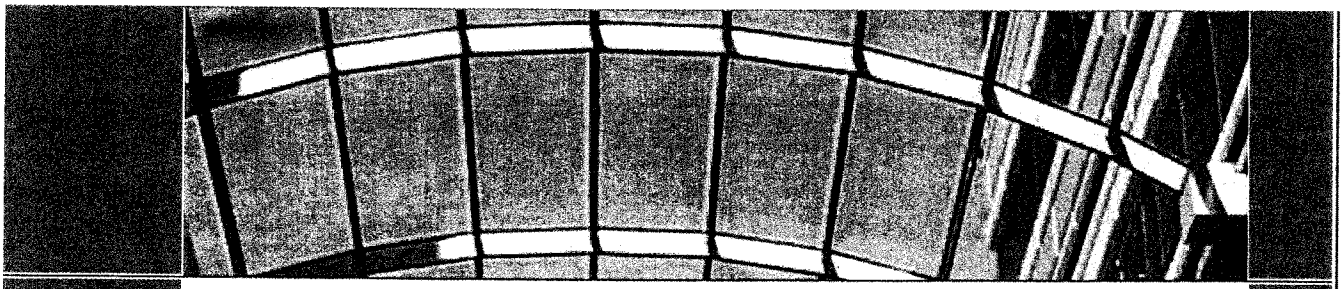

The Adverse Childhood Experiences (ACE) Study:

Bridging the gap between childhood trauma and negative consequences later in life.

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Services

V. J. Felitti, MD
Kaiser Permanente

R. F. Anda, MD, MS
Centers for Disease Control and Prevention

What is the ACE Study?

The ACE Study is an ongoing collaboration between the Centers for Disease Control and Prevention and Kaiser Permanente. Led by Co-principal Investigators Robert F. Anda, MD, MS, and Vincent J. Felitti, MD, the ACE Study is perhaps the largest scientific research study of its kind, analyzing the relationship between multiple categories of childhood trauma (ACEs), and health and behavioral outcomes later in life.

What's an ACE?

Growing up experiencing any of the following conditions in the household prior to age 18:

1. Recurrent physical abuse
2. Recurrent emotional abuse
3. Contact sexual abuse
4. An alcohol and/or drug abuser in the household
5. An incarcerated household member
6. Someone who is chronically depressed, mentally ill, institutionalized, or suicidal
7. Mother is treated violently
8. One or no parents
9. Emotional or physical neglect

The ACE Score

The ACE Study used a simple scoring method to determine the extent of each study participant's exposure to childhood trauma. Exposure to one category (not incident) of ACE, qualifies as one point. When the points are added up, the ACE Score is achieved. An ACE Score of 0 (zero) would mean that the person reported no exposure to any of the categories of trauma listed as ACEs above. An ACE Score of 9 would mean that the person reported exposure to all of the categories of trauma listed above. The ACE Score is referred to throughout all of the peer-reviewed publications about the ACE Study findings.

What's YOUR ACE Score? Help me calculate my ACE Score.

The ACE Study is based upon data collected from over 17,000 adult participants, and no new study participants are being accepted. However, you might like to know your own ACE Score, so that the information you read about the Study is more meaningful to you.

Finding Your ACE Score

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household **often or very often**...
   Swear at you, insult you, put you down, or humiliate you?
   or
   Act in a way that made you afraid that you might be physically hurt?
   Yes No If yes enter 1 _____

2. Did a parent or other adult in the household **often or very often**...
   Push, grab, slap, or throw something at you?
   or
   Ever hit you so hard that you had marks or were injured?
   Yes No If yes enter 1 _____

3. Did an adult or person at least 5 years older than you **ever**...
   Touch or fondle you or have you touch their body in a sexual way?
   or
   Attempt or actually have oral, anal, or vaginal intercourse with you?
   Yes No If yes enter 1 _____

4. Did you **often or very often** feel that ...
   No one in your family loved you or thought you were important or special?
   or
   Your family didn't look out for each other, feel close to each other, or support each other?
   Yes No If yes enter 1 _____

5. Did you **often or very often** feel that ...
   You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you?
   or
   Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?
   Yes No If yes enter 1 _____

6. Were your parents **ever** separated or divorced?
   Yes No If yes enter 1 _____

7. Was your mother or stepmother:
   Often or very often pushed, grabbed, slapped, or had something thrown at her?
   or
   Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard?
   or
   Ever repeatedly hit at least a few minutes or threatened with a gun or knife?
   Yes No If yes enter 1 _____

8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?
   Yes No If yes enter 1 _____

9. Was a household member depressed or mentally ill, or did a household member attempt suicide?
   Yes No If yes enter 1 _____

10. Did a household member go to prison?
    Yes No If yes enter 1 _____

Now add up your "Yes" answers: _____ This is your ACE Score.

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ChildTrauma a·c·a·d·e·m·y

Search

CTA Mission

The mission of the ChildTrauma Academy is to help improve the lives of traumatized and maltreated children -- by improving the systems that educate, nurture, protect and enrich these children. We focus our efforts on education, service delivery, program consultation, research and innovations in clinical assessment/treatment.

CTA Strategy

Essential to this process is the collaboration of all sectors of society. As such, we engage in a continuous process of identifying key partners, drawn from academia, the corporate world, private organizations and public sector systems. While each partnership has a distinct focus-- identifying best practices in child protection, evaluating the latest research in child development, defining optimal ways to provide resources to parents or creating a novel therapeutic approach with traumatized children-- all are engaged in the continuous process of testing, refining and distributing innovations that can improve the lives of children.

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Childhood Experience and the Expression of Genetic Potential: What Childhood Neglect Tells Us About Nature and Nurture

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Abstract. Studies of childhood abuse and neglect have important lessons for considerations of nature and nurture. While each child has unique genetic potentials, both human and animal studies point to important needs that every child has, and severe long-term consequences for brain function if those needs are not met. The effects of the childhood environment, favorable or unfavorable, interact with all the processes of neurodevelopment (neurogenesis, migration, differentiation, apoptosis, arborization, synaptogenesis, synaptic sculpting, and myelination). The time courses of all these neural processes are reviewed here along with statements of core principles for both genetic and environmental influences on all of these processes. Evidence is presented that development of synaptic pathways tends to be a "use it or lose it" proposition. Abuse studies from the author's laboratory, studies of children in orphanages who lacked emotional contact, and a large number of animal deprivation and enrichment studies point to the need for children and young nonhuman mammals to have both stable emotional attachments with and touch from primary adult caregivers, and spontaneous interactions with peers. If these connections are lacking, brain development both of caring behavior and cognitive capacities is damaged in a lasting fashion. These effects of experience on the brain imply that effects of modern technology can be positive but need to be monitored. While technology has raised opportunities for children to become economically secure and literate, more recent inadvertent impacts of technology have spawned declines in extended families, family meals, and spontaneous peer interactions. The latter changes have deprived many children of experiences that promote positive growth of the cognitive and caring potentials of their developing brains.

Archeology first documents evidence of written language 5000 years ago in the Middle East. The genetic potential for humankind to learn and use written language had been present, but unexpressed, for 200,000 years prior to the first invention of written language.

One thousand years ago, less than 1% of the population of Western Europe could read. Essentially all of the population had the genetic potential to learn to read yet this potential remained untapped until the advent of universal public education.

In 1211, Frederick II, Emperor of Germany, in an attempt to discover the natural "language of God," raised dozens of children in silence. God's preferred language never emerged; the children never spoke any language and all ultimately died in childhood (van Cleve, 1972).

More than 200,000 years ago, the first homo sapiens sapiens, our genetic ancestors, began to spread across the planet. For 99 percent of the time our species has been on this planet, we lived in small hunter-gatherer clans. Humans lived with few material possessions, no written language, no complex world economy, advanced technologies or systems of governance. The major predator of humans was (and remains) other humans – usually from competing clans or bands. The lifespan was short, infant mortality high and the overall population of on the planet only slowly increased over tens of thousands of years. How different our Earth is today!

Only one of thousands of mammals on the planet, humankind – slow, naked and weak creatures, biologically suited to few of the Earth's many climates and ecosystems – ultimately came to dominate the planet. Humankind is now capable of living in all of the planet's climates and harsh environments. No longer bound by cold, absence of natural grains or migrating herds, the natural boundaries of sea and sky, we humans – unlike any other of the planet's species – have created our own world. We have learned to cultivate natural grains and fruits – and now alter their genome; to domesticate and now, create, other animal species; from our own genetic capacity to make complex associations, symbolic representations and 40 basic sounds we have created 10,000 languages, and invented writing; we have invented belief systems, styles of governance, housing, economies – we have invented ourselves. We have made our own world with its own rules. In good ways and in bad, we stand out from all other species. So much so that we often forget that we are ultimately accountable to the laws of nature.

Yet we *are* biological creatures, bound by the laws of nature to a time-limited existence. We are conceived and born, live our lives and then we die. From conception to death, our biological matrix organizes in remarkably complex ways to create multiple organ systems – bone and muscle, heart and liver, senses and brain. These biological systems allow each of us to move through space and time in a host of natural and, now, man-made, environments, interacting in complex ways with a diversity of biological creatures and environments. Within that single lifetime the range and variety in how we live is stunning. Genetically-comparable humans can live as Inuit in the tundra of Nunavut, a banker on Wall Street, a hunter-gatherer in the rainforest in Brazil. At times, a life is lived with grace and beauty, sharing with and caring for others, creating ideas, objects and concepts never before known on this planet. And at other times humans are cruel, ruthless and destructive – both random and systematic in the ways we destroy, hate and kill. How is this possible in the same species?

This question has been at the heart of centuries of debate on the "nature" of humankind. Are we born evil – natural born killers or the most creative and compassionate of all animals? Are we both? Does our best and our worst come from our genes or from our learning? Nature or nurture? These questions have tainted political, sociocultural and scientific processes for thousands of years. Its simplicity – suggesting that the essence of a person is the inevitable product of one or the other – genes or learning – is seductive. The human mind tends to prefer

simple linear explanations rather than complex ambiguity. Unfortunately, simple categorical explanations of humankind feed destructive belief systems and deflect from a healthy process of inquiry about our true complexity.

We now know more about our genes and more about the influence of experience on shaping biological systems that ever before. What do these advances tell us about the nature or nurture debate? Simply, they tell us that this is a foolish argument. Humans are the product of nature *and* nurture. Genes and experience are interdependent. Genes are merely chemicals and without "experience" – with no context, no microenviromental signals to guide their activation or deactivation – create nothing. And "experiences" without a genomic matrix cannot create, regulate or replicate life of any form. The complex process of creating a human being – and humanity – requires both. The amazing malleability and adaptability of humankind is allowed by our genetically-mediated capacity to perceive and respond to myriad environmental cues including the complex social-emotional milieu created when humans live together; and the organ most sensitive and responsive to the environment is the human brain.

The Human Brain

Humankind's transient but magnificent rebellion against nature is allowed by the brain. In ways not yet understood, activation of neural networks – chains of neurons – allow us to think, feel and act. It is our brain which allows us to laugh, cry, hope and act in humane ways. It is the brain that mediates our humanity – or not.

Yet the brain's prime mandate is survival of the species. The human nervous system senses, processes, stores and acts on information from the inside and outside environments to promote survival of the species. Three key brain-mediated capabilities must be present for our species to survive: individual survival, procreation and the protection and nurturing of dependents. Failure in any of these three areas would lead to extinction of our species. The brain, therefore, has crucial neural systems dedicated to (1) the stress response and responding to threats – from internal and external sources; (2) the process of mate selection and reproduction and (3) protecting and nurturing dependents, primarily the young.

The primary strategy we use to meet these objectives is to create relationships. Relationships which allow us to attach, affiliate, communicate and interact to promote survival, procreation and the protection of dependents. It is the brain that allows humans to form the relationships which connect us – one to another – creating the myriad groups – that have been the key to our success on this planet. It is not as independent and solitary individuals that we succeed; it through our interdependent relationships – our families, clans, communities and societies – that we survive and thrive. We need each other. Therefore, some of the most powerful and complex neural systems in the human are dedicated to social affiliation and communication.

Yet even these essential neural systems do not develop without necessary experiences. The neural systems which allow us to create relationships – and think, feel and act – are the product of the interactive, dynamic processes taking place during the history of each individual. These neural systems, then, are created, organize and change in response to experience throughout the life-cycle. The time in life, however, when the brain is most sensitive to experience – and therefore most easy to influence in positive and negative ways is in infancy and childhood. It is during these times in life when social, emotional, cognitive and physical experiences will shape neural systems in ways that influence functioning for a lifetime. This is a time of great opportunity – and great vulnerability – for expressing the genetic potentials in a child.

Neurodevelopment

The mature human brain is comprised of 100 billion neurons and ten times as many glial cells – connected by trillions of synapses all. A complex dynamic of continuous activity, it is the product of neurodevelopment – a long process orchestrating billions upon billions of complex chemical transactions.

In a few short years, one single cell – the fertilized egg – becomes a walking, talking, learning, loving, and thinking being. In each of the billions of cells in the body, a single set of genes has been expressed in millions of different combinations with precise timing. Development is a breathtaking orchestration of precision micro-construction that results in a human being. The most complex of all the organs in the human body is the human brain. In order to create the brain, a small set of pre-cursor cells must divide, move, specialize, connect and create specialized neural networks that form functional units. This requires nature and nurture. The key role of genetics and environment are outlined for eight of the key neurodevelopmental processes involved in creating a mature, functional human brain.

MAJOR PROCESSES OF NEURODEVELOPMENT

1. Neurogenesis: The brain develops from cells present in the embryo in the first weeks following conception. From these few undifferentiated cells, come billions of nerve cells and trillions of glia. The vast majority of neurogenesis, the "birth" of neurons, takes place in utero during the second and third trimester. At birth, the vast majority of neurons used for the remainder of life are present. Few neurons are born after birth, although researchers have demonstrated recently that neurogenesis does take place in the mature brain (Gould *et al.*, 1999). Neurogenesis in the mature brain may be one of the important physiological mechanisms responsible for the brain's plasticity (i.e., capacity to restore function) following injury.

Despite being present at birth, most neurons have yet to organize into completely functional systems. The billions of neurons present at birth need to

further specialize and connect with other neurons in order to create the functional neural networks of the mature brain.

2. *Migration*: As neurons are born and the brain grows, neurons move. Often guided by glial cells and a variety of chemical markers (e.g., cellular adhesion molecules, nerve growth factor: NGF), neurons cluster, sort, move and settle into a location in the brain that will be their final "resting" place. It is the fate of some neurons to settle in the brainstem, others in the cortex, for example. Cortical cell migration and fate mapping are some of the most studied processes in developmental neuroscience (Rakic, 1981, 1996). It is clear that both genetic and environmental factors play important roles in determining a neuron's final location.

Migration takes place primarily during the intrauterine and immediate perinatal period but continues throughout childhood and, possibly, to some degree into adult life. A host of intrauterine and perinatal insults – experiences such as infection, lack of oxygen, exposure to alcohol and various psychotropic drugs can alter migration of neurons and have profound impact on the expression of genetic potentials for a host of functions (see Perry, 1988).

3. *Differentiation*: Neurons specialize during development. Each of the 100 billion neurons in the brain has the same set of genes, yet each neuron is expressing a unique combination of those genes to create a unique neurochemistry, neuroarchitecture and functional capability. Some neurons are large, with long axons; others short. Neurons can mature to use any of a hundred different neurotransmitters such as norepinephrine, dopamine, serotonin, CRF or substance P. Neurons can have dense dendritic fields receiving input from hundreds of other neurons, while other neurons can have a single linear input from one other neuron. Each of these thousands of differentiating "choices" are the product of the pattern, intensity and timing of various microenvironmental cues, i.e., experience, which tell the neuron to turn on some genes and turn off others. Each neuron undergoes a series of "decisions" to determine their final location and specialization. These decisions, again, are a combination of genetic and microenvironmental cues. Neurons are specialized to change in response to chemical signals. Therefore, any experience or event that alters neurochemical or micro-environmental signals during development can change the ways in which certain neurons differentiate, thereby altering the functional capacity of the neural networks in which these neurons reside (e.g., Rutledge *et al.*, 1974).

4. *Apoptosis*: During development, redundant or under-activated neurons die. In many areas of the brain, there are more neurons born than are required to make a functional system. Many of these neurons are redundant and when unable to adequately "connect" into an active neural network will die (Kuan *et al.*, 2000). Research in this area suggests that these neurons may play a role in the remarkable flexibility present in the human brain at birth. Depending upon the challenges of the

environment and the potential needs of the individual, some neurons will survive while others will not. Again, this process appears to have genetic *and* environmental determinants. Neurons that make synaptic connections with others and have an adequate level of activation will survive; neurons with little activity resorb. This is one example of a general principle of activity-dependence ("use it or lose it") that appears to be important in many neural processes related to learning, memory and development (see below).

5. Arborization: As neurons differentiate, they send out one form of fiber-like processes called dendrites. Dendrites become the receptive area where other neurons connect. Dozens to hundreds of other neurons are able to connect to one neuron via this dendritic tree. The density of these dendritic branches is related to the frequency and intensity of incoming signals. When there is high activity, the dendritic network extends. This arborization allows the neuron to receive, process and integrate complex patterns of input that, in turn, influence its activity – including the activity and specificity of gene transcription. In turn, the neural signals coming into any give neuron are often dependent upon the complexity and activity of the sensory experiences of the animal (Diamond *et al.*, 1966; Greenough *et al.*, 1973). Dendritic density appears to be one of the most experience-sensitive physical features of a neuron.

6. Synaptogenesis: The most experience-sensitive feature of a neuron is, however, the synapse. Developing neurons also send out fiber-like processes which become axons and synapses. The major mechanism for neuron-to-neuron communication is 'receptor-mediated' neurotransmission that takes place at specialized connections between neurons called synapses. At the synapse, the distance between two neurons is very short. A chemical (classified as a neurotransmitter, neuromodulator or neurohormone) is released from the 'presynaptic' neuron into the extra-cellular space (called the synaptic cleft). The neurotransmitter crosses the synaptic cleft and binds to a specialized receptor protein in the membrane of the 'postsynaptic' neuron. By occupying the binding site, the neurotransmitter helps change the shape of this receptor which results in a cascade of catalyzed chemical reactions mediated by "second messengers" such as cyclic AMP, inositol phosphate and calcium. In turn, these chemicals shift the intracellular chemical milieu which will influence the activity of specific genes. This cascade of intracellular chemical responses allows communication from one neuron to another.

A continuous dynamic of synaptic neurotransmission regulates the activity and functional properties of the chains of neurons that allow the brain to do all of its remarkable activities. These neural connections are not random. They are guided by important genetic and environmental cues. In order for our brain to function properly, neurons, during development, need to find and connect with the "right" neurons. During the differentiation process, neurons send fiber-like projections (growth cones) out to make physical contact with other neurons. This process

appears to be regulated and guided by certain growth factors and cellular adhesion molecules that attract or repel a specific growth cone to appropriate target neurons. Depending upon a given neuron's specialization, these growth cones will grow (becoming axons) and connect to the dendrites of other cells and create a synapse. During the first eight months of life there is an eight-fold increase in synaptic density while the developing neurons in the brain are "seeking" their appropriate connections (Huttenlocher, 1979, 1994). This explosion of synaptogenesis allows the brain to have the flexibility to organize and function with a wide range of potential. It is over the next few years, in response to patterned repetitive experiences that these neural connections will be refined and sculpted.

7. Synaptic sculpting: The synapse is a dynamic structure. With continuous, but episodic release of neurotransmitter, occupation of receptors, release of growth factors, shifts of ions in and out of cells, laying down of new microtubules and other structural molecules, the synapse is continually changing. A key determinant in this synaptic sculpting process is the level of pre-synaptic activity. When there is a consistent active process of neurotransmitter release, synaptic connections will be strengthened with actual physical changes that make the pre- and post-synaptic neurons grow closer together, making neurotransmission between these two neurons more efficient.

When there is little activity, the synaptic connection will literally dissolve. The specific axonal branch to a given neuron will go away. While somewhat simplistic, it appears that synaptic sculpting is a "use it or lose it" process (see below). This powerful activity-dependent process appears to be the molecular basis of learning, memory and, therefore, at the core of neurodevelopment.

8. Myelination: Specialized glial cells wrap around axons and, thereby, create more efficient electrochemical transduction down the neuron. This allows a neural network to function more rapidly and efficiently, thereby allowing more complex functioning (e.g., walking depends upon the myelination of neurons in the spinal cord for efficient, smooth regulation of neuromotor functioning.) The process of myelination begins in the first year of life but continues in many key areas throughout childhood with a final burst of myelination in key cortical areas taking place in adolescence.

The eight key neurodevelopmental processes described above are dependent upon the genome and environmentally-determined microenvironmental cues (e.g., neurotransmitters, neuromodulators, neurohormones, ions, growth factors, cellular adhesion molecules and other morphogens). Disruption of the pattern, timing or intensity of these cues can lead to abnormal neurodevelopment and profound dysfunction. The *specific* dysfunction will depend upon the timing of the insult (e.g., was the insult *in utero* during the development of the brainstem or at age two during the active development of the cortex), the nature of the insult (e.g., is there a lack of sensory stimulation from neglect or an abnormal persisting activation of

the stress response from trauma?), the pattern of the insult (i.e., is this a discreet single event, a chronic experience with a chaotic pattern or an episodic event with a regular pattern?) (see Perry, 2001a).

Several key principles emerge from the research on these neurodevelopmental processes. These principles, as outlined below, further suggest that while the structural organization and functional capabilities of the mature brain can change throughout life, the majority of the key stages of neurodevelopment take place in childhood.

CORE PRINCIPLES OF NEURODEVELOPMENT

1. Genetic and environmental influences: Genes are designed to work in an environment. Genes are expressed by microenvironmental cues, which, in turn, are influenced by the experiences of the individual. How an individual functions within an environment, then, is dependent upon the expression of a unique combination of genes available to the human species. We don't have the genes to make wings. ***And*** what we become depends upon how experiences shape the expression – or not – of specific genes we *do* have. For thousands of years, the genetic potential to use "joysticks" was not expressed – nor that for written language or reading. Yet when experiences are provided in a structured, patterned and appropriately timed way, that potential can be expressed and neural systems which mediate all of those functions will develop.

The influence of gene-driven processes, however, shifts during development. In the just fertilized ovum, all of the chemical processes that are driving development are very dependent upon a genetically-determined sequence of molecular events. By birth, however, the brain has developed to the point where environmental cues mediated by the senses play a major role in determining how neurons will differentiate, sprout dendrites, form and maintain synaptic connections and create the final neural networks that convey functionality. By adolescence, the majority of the changes that are taking place in the brain of that child are determined by experience, not genetics. The languages, beliefs, cultural practices, and complex cognitive and emotional functioning (e.g., self esteem) by this age are primarily experience-based.

2. Sequential developmental: The brain develops in a sequential and hierarchical fashion; organizing itself from least (brainstem) to most complex (limbic, cortical areas). These different areas develop, organize and become fully functional at different times during childhood. At birth, for example, the brainstem areas responsible for regulating cardiovascular and respiratory function must be intact for the infant to survive, and any malfunction is immediately observable. In contrast, the cortical areas responsible for abstract cognition have years before they will be 'needed' or fully functional.

This means that each brain area will have its own timetable for development. The neurodevelopmental processes described above will be most active in different brain areas at different times and will, therefore, either require (critical periods) or be sensitive to (sensitive periods) organizing experiences (and the neurotrophic cues related to these experiences). The neurons for the brainstem have to migrate, differentiate and connect, for example, before the neurons for the cortex.

The implications of this are profound. In the development of socio-emotional functioning, early life nurturing appears to be critical. If this is absent for the first three years of life and then a child is adopted and begins to receive attention, love and nurturing, these positive experiences may not be sufficient to overcome the malorganization of the neural systems mediating socio-emotional functioning. Disruptions of experience-dependent neurochemical signals during early life may lead to major abnormalities or deficits in neurodevelopment. Disruption of critical neurodevelopmental cues can result from (1) lack of sensory experience during sensitive periods (e.g., neglect) or (2) atypical or abnormal patterns of necessary cues due to extremes of experience (e.g., traumatic stress, see Perry, 2001a).

3. Activity-dependent neurodevelopment: The brain organizes in a use-dependent fashion. As described above, many of the key processes in neurodevelopment are activity dependent. In the developing brain, undifferentiated neural systems are critically dependent upon sets of environmental and micro-environmental cues (e.g., neurotransmitters, cellular adhesion molecules, neurohormones, amino acids, ions) in order for them to appropriately organize from their undifferentiated, immature forms (Lauder, 1988; Perry, 1994b; Perry and Pollard, 1998). Lack, or disruption, of these critical cues can alter the neurodevelopmental processes of neurogenesis, migration, differentiation, synaptogenesis – all of which can contribute to malorganization and diminished functional capabilities in the specific neural system where development has been disrupted. This is the core of a neuroarcheological perspective on dysfunction related adverse childhood events (Perry, 2001b). These molecular cues that guide development are dependent upon the experiences of the developing child. The quantity, pattern of activity and nature of these neurochemical and neurotrophic factors depends upon the presence and the nature of the total sensory experience of the child. When the child has adverse experiences – loss, threat, neglect, and injury – there can be disruptions of neurodevelopment that will result in neural organization that can lead to compromised functioning throughout life (see below).

4. Windows of opportunity/windows of vulnerability: The sequential development of the brain and the activity-dependence of many key aspects of neurodevelopment suggest that there must be times during development when a given developing neural system is more sensitive to experience than others. In healthy development, that sensitivity allows the brain to rapidly and efficiently organize in response to the unique demands of a given environment to express from its broad genetic

potential those characteristics which best fit that child's world. If the child speaks Japanese as opposed to English, for example, or if this child will live in the plains of Africa or the tundra of the Yukon, different genes can be expressed, different neural networks can be organized from that child's potential to best fit that family, culture and environment. We all are aware of how rapidly young children can learn language, develop new behaviors and master new tasks. The very same neurodevelopmental sensitivity that allows amazing developmental advances in response to predictable, nurturing, repetitive and enriching experiences make the developing child vulnerable to adverse experiences.

Sensitive periods are different for each brain area and neural system, and therefore, for different functions. The sequential development of the brain and the sequential unfolding of the genetic map for development mean that the sensitive periods for neural system (and the functions they mediate) will be when that system is in the developmental 'hot zone' – when that area is most actively organizing. The brainstem must organize key systems by birth; therefore, the sensitive period for those brainstem-mediated functions is during the prenatal period. The neocortex, in contrast, has systems and functions organizing throughout childhood and into adult life. The sensitive periods for these cortically mediated functions are likely to be very long.

The simple and unavoidable conclusion of these neurodevelopmental principles is that the organizing, sensitive brain of an infant or young child is more malleable to experience than a mature brain. While experience may alter the behavior of an adult, experience literally provides the organizing framework for an infant and child. Because the brain is most plastic (receptive to environmental input) in early childhood, the child is most vulnerable to variance of experience during this time.

Two forms of "neglect" will be considered below: extreme multi-sensory neglect in childhood and a more subtle, insidious decrease in our opportunities to elaborate our socio-emotional potential caused by the sociocultural changes in how we choose to live. The sensory deprivation neglect results in obvious alterations in neurobiology and function while the second form has an almost invisible toxic impact on the developing child – and ultimately, society.

The Neurodevelopmental Impact of Neglect in Childhood

Neglect is the absence of critical organizing experiences at key times during development. Despite its obvious importance in understanding child maltreatment, neglect has been understudied. Indeed, deprivation of critical experiences during development may be the most destructive yet the least understood area of child maltreatment. There are several reasons for this. The most obvious is that neglect is difficult to "see." Unlike a broken bone, maldevelopment of neural systems mediating empathy, for example, resulting from emotional neglect during infancy is not readily observable.

Another important, yet poorly appreciated, aspect of neglect is the issue of timing. The needs of the child shift during development; therefore, what may be neglectful at one age is not at another. The very same experience that is essential for life at one stage of life may be of little significance or even inappropriate at another age. We would all question the mother who held, rocked and breastfed her pubescent child. Touch, for example, is essential during infancy. The untouched newborn may literally die; in Spitz' landmark studies, the mortality rates in the institutionalized infants was near thirty percent (Spitz, 1945, 1946). If one doesn't touch an adolescent for weeks, however, no significant adverse effects will result. Creating standardized protocols, procedures and "measures" of neglect, therefore, are significantly confounded by the shifting developmental needs and demands of childhood. Finally, neglect is understudied because it is very difficult to find large populations of humans where specific and controlled neglectful experiences have been well documented. In some cases, these cruel experiments of humanity have provided unique and promising insights (see below). In general, however, there will never be – and there never should be – the opportunity to study neglect in humans with the rigor that can be applied in animal models.

With these limitations, however, what we do know about neglect during early childhood supports a neuroarcheological view of adverse childhood experience. The earlier and more pervasive the neglect is, the more devastating the developmental problems for the child. Indeed, chaotic, inattentive and ignorant caregiving can produce pervasive developmental delay (PDD; DSM IV-R) in a young child (Rutter *et al.*, 1999). Yet the very same inattention for the same duration if the child is ten will have very different and less severe impact than inattention during the first years of life.

There are two main sources of insight to childhood neglect. The first is the indirect but more rigorous animal studies and the second is a growing number of descriptive reports with severely neglected children.

Environmental Manipulation and Neurodevelopment: Animal Studies

Some of the most important studies in developmental neurosciences in the last century have been focusing on various aspects of experience and extreme sensory experience models. Indeed, the Nobel Prize was awarded to Hubel and Wiesel for their landmark studies on development of the visual system using sensory deprivation techniques (Hubel and Wiesel, 1963). In hundreds of other studies, extremes of sensory deprivation (Hubel and Wiesel, 1970; Greenough *et al.*, 1973) or sensory enrichment (Greenough and Volkmar, 1973; Diamond *et al.*, 1964; Diamond *et al.*, 1966) have been studied. These include disruptions of visual stimuli (Coleman and Riesen, 1968), environmental enrichment (Altman and Das, 1964; Cummins and Livesey. 1979), touch (Ebinger, 1974; Rutledge *et al.*, 1974), and other factors that alter the typical experiences of development (Uno *et al.*, 1989; Plotsky and Meaney, 1993; Meaney *et al.*, 1988). These findings generally demonstrate that the brains of

animals reared in enriched environments are larger, more complex and functional more flexible than those raised under deprivation conditions. Diamond's work, for example, examining the relationships between experience and brain cytoarchitecture have demonstrated a relationship between density of dendritic branching and the complexity of an environment (for a good review of this and related data see (Diamond and Hopson, 1998)). Others have shown that rats raised in environmentally enriched environments have higher density of various neuronal and glial microstructures, including a 30% higher synaptic density in cortex compared to rats raised in an environmentally deprived setting (Altman and Das, 1964; Bennett *et al.*, 1964). Animals raised in the wild have from 15 to 30% larger brain mass than their offspring who are domestically reared (Darwin, 1868; Rehkamper *et al.*, 1988; Rohrs, 1955; Rohrs and Ebinger, 1978).

Animal studies suggest that critical periods exist during which specific sensory experience was required for optimal organization and development of the part of the brain mediating a specific function (e.g., visual input during the development of the visual cortex). While these phenomena have been examined in great detail for the primary sensory modalities in animals, few studies have examined the issues of critical or sensitive periods in humans. What evidence there is would suggest that humans tend to have longer periods of sensitivity and that the concept of critical period may not be useful in humans. It is plausible, however, that abnormal microenvironmental cues and atypical patterns of neural activity during sensitive periods in humans could result in malorganization and compromised function in a host of brain-mediated functions. Indeed, altered emotional, behavioral, cognitive, social and physical functioning has been demonstrated in humans following specific types of neglect. The majority of this information comes from the clinical rather than the experimental disciplines.

THE IMPACT OF NEGLECT IN EARLY CHILDHOOD: CLINICAL FINDINGS

Over the last sixty years, many case reports, case series and descriptive studies have been conducted with children neglected in early childhood. The majority of these studies have focused on institutionalized children. As early as 1833, with the famous Kaspar Hauser, feral children had been described (Heidenreich, 1834). Hauser was abandoned as a young child and raised from early childhood (likely around age two) until seventeen in a dungeon, experiencing relative sensory, emotional and cognitive neglect. His emotional, behavioral and cognitive functioning was, as one might expect, very primitive and delayed.

In the early forties, Spitz described the impact of neglectful caregiving on children in foundling homes (orphanages). Most significant, he was able to demonstrate that children raised in fostered placements with more attentive and nurturing caregiving had superior physical, emotional and cognitive outcomes (Spitz, 1945, 1946). Some of the most powerful clinical examples of this phenomenon are related to profound neglect experiences early in life.

In a landmark report of children raised in a Lebanese orphanage, the Creche, Dennis (1973) described a series of findings supporting a neuroarcheological model of maltreatment. These children were raised in an institutional environment devoid of individual attention, cognitive stimulation, emotional affection or other enrichment. Prior to 1956 all of these children remained at the orphanage until age six, at which time they were transferred to another institution. Evaluation of these children at age 16 demonstrated a mean IQ of approximately 50. When adoption became common, children adopted prior to age 2 had a mean IQ of 100 by adolescence while children adopted between ages 2 and 6 had IQ values of approximately 80 (Dennis, 1973). This graded recovery reflected the neuroarcheological impact of neglect. A number of similar studies of children adopted from neglectful settings demonstrate this general principle. The older a child was at time of adoption, (i.e., the longer the child spent in the neglectful environment) the more pervasive and resistant to recovery were the deficits.

Money and Annecillo (1976) reported the impact of change in placement on children with psychosocial dwarfism (failure to thrive). In this preliminary study, 12 of 16 children removed from neglectful homes recorded remarkable increases in IQ and other aspects of emotional and behavioral functioning. Furthermore, they reported that the longer the child was out of the abusive home the higher the increase in IQ. In some cases IQ increased by 55 points (Money and Annecillo, 1976).

A more recent report on a group of 111 Romanian orphans (Rutter *et al.*, 1998; Rutter *et al.*, 1999) adopted prior to age two from very emotionally and physically depriving institutional settings demonstrate similar findings. Approximately one half of the children were adopted prior to age six months and the other half between six months and 2 years old. At the time of adoption, these children had significant delays. Four years after being placed in stable and enriching environments, these children were re-evaluated. While both groups improved, the group adopted at a younger age had a significantly greater improvement in all domains. As a group, these children were at much greater risk for meeting diagnostic criterion for autism-spectrum disorder, a finding that sheds light on the evolving relationships between early life trauma, neglect and subsequent development of severe neuropsychiatric problems including psychotic disorders and schizophrenia (Read *et al.*, 2001).

These observations are consistent with the clinical experiences of the ChildTrauma Academy working with maltreated children for the last fifteen years. During this time we have worked with more than 1000 children neglected in some fashion. We have recorded increases in IQ of over 40 points in more than 60 children following removal from neglectful environments and placed in consistent, predictable, nurturing, safe and enriching placements (Perry *et al.*, in preparation). In addition, in a study of more than 200 children under the age of 6 removed from parental care following abuse and neglect we demonstrated significant developmental delays in more than 85% of the children. The severity of these developmental problems increased with age, suggesting, again, that the longer the

child was in the adverse environment – the earlier and more pervasive the neglect – the more indelible and pervasive the deficits.

NEGLECT IN EARLY CHILDHOOD: NEUROBIOLOGICAL FINDINGS

All of these reported developmental problems – language, fine and large motor delays, impulsivity, disorganized attachment, dysphoria, attention and hyperactivity, and a host of others described in these neglected children – are caused by abnormalities in the brain. Despite this obvious statement, very few studies have examined directly any aspect of neurobiology in neglected children. Yet clues exist. On autopsy, the brain of Kasper Hauser was notable for small cortical size and few, non-distinct cortical gyri – all consistent with cortical atrophy (Simon, 1978).

Our group has examined various aspects of neurodevelopment in neglected children (Perry and Pollard, 1997). Neglect was considered global neglect when a history of relative sensory deprivation in more than one domain was obtained (e.g., minimal exposure to language, touch and social interactions). Chaotic neglect is far more common and was considered present if history was obtained that was consistent with physical, emotional, social or cognitive neglect. History was obtained from multiple sources (e.g., investigating CPS workers, family, and police). The neglected children (n = 122) were divided into four groups: Global Neglect (GN; n = 40); Global Neglect with Prenatal Drug Exposure (GN+PND; n = 18); Chaotic Neglect (CN; n = 36); Chaotic Neglect with Prenatal Drug Exposure (CN+PND; n = 28). Measures of growth were compared across group and compared to standard norms developed and used in all major pediatric settings.

Dramatic differences from the norm were observed in FOC (the frontal-occipital circumference, a measure of head size and in young children a reasonable measure of brain size). In the globally neglected children the lower FOC values suggested abnormal brain growth. For these globally neglected children the group mean was below the 5th percentile. In contrast, the chaotically neglected children did not demonstrate this marked group difference in FOC. Furthermore in cases where MRI or CT scans were available, neuroradiologists interpreted 11 of 17 scans as abnormal from the children with global neglect (64.7%) and only 3 of 26 scans abnormal from the children with chaotic neglect (11.5%). The majority of the readings were "enlarged ventricles" or "cortical atrophy" (see Figure 1).

In following these globally-neglected children over time we observed some recovery of function and relative brain-size when these children were removed from the neglectful environment and placed in foster care (see Figure 2). The degree of recovery over a year period however was inversely proportional to age in which the child was removed from the neglecting caregivers. The earlier in life and the less time in the sensory-depriving environment, the more robust the recovery.

These findings strongly suggest that when early life neglect is characterized by decreased sensory input (e.g., relative poverty of words, touch and social interactions) there will be a similar effect on human brain growth as in other mammalian

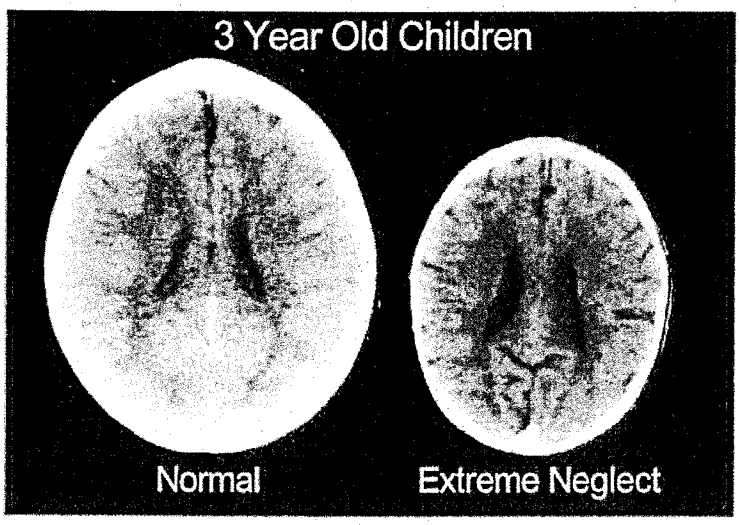

Figure 1. Abnormal brain development following sensory neglect in early childhood. These images illustrate the negative impact of neglect on the developing brain. In the CT scan on the left is an image from a healthy three year old with an average head size (50th percentile). The image on the right is from a three year old child suffering from severe sensory-deprivation neglect. This child's brain is significantly smaller than average (3rd percentile) and has enlarged ventricles and cortical atrophy.

species. The human cortex grows in size, develops complexity, makes synaptic connections and modifies as a function of the quality and quantity of sensory experience. Sensory-motor and cognitive deprivation leads to underdevelopment of the cortex in rats, non-human primates and humans.

Studies from other groups are beginning to report similar altered neurodevelopment in neglected children. In the study of Romanian orphans described above, the 38% had FOC values below the third percentile (greater than 2 SD from the norm) at the time of adoption. In the group adopted after six months, fewer than 3% and the group adopted after six months 13% had persistently low FOCs four years later (Rutter *et al.*, 1998; O'Connor *et al.*, 2000). Strathearn (submitted) has followed extremely low birth weight infants and shown that when these infants end up in neglectful homes they have a significantly smaller head circumference at 2 and 4 years, but not at birth. This is despite having no significant difference in other growth parameters.

More recently advanced neuroimaging techniques have demonstrated altered brain development in neglected children. Chugani and colleagues have been pioneers in neuroimaging studies in maltreated children. Their most recent study using functional MRI in Romanian orphans has demonstrated decreased metabolic activity in the orbital frontal gyrus, the infralimbic prefrontal cortex, the amygdala

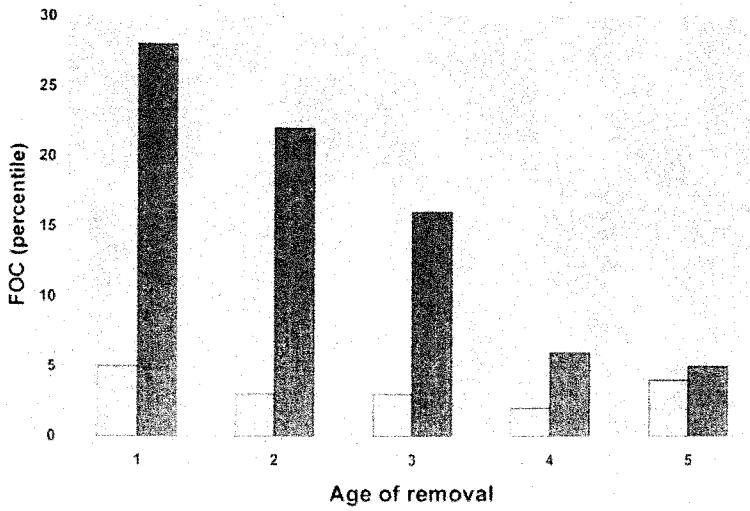

Figure 2. Sensory deprivation neglect: effects of early removal on recovery. Children were removed from neglectful environments at different ages (ages 8 months to 5.7 years). Their frontal-occipital circumference was measured and compared to same-aged norms (blue bars). Children were placed in foster care and one year later re-evaluated. FOC was measured (maroon bars) and in each group increased although with increasing age, the improvement after a year of foster placement started to decrease such that children removed after four years in the neglectful setting had no statistically-significant improvement one year later. Data are from 112 children with some form of severe neglect in the first five years of life (modified from Perry and Pollard, 1997).

and head of the hippocampus, the lateral temporal cortex and in the brainstem (Chugani *et al.*, 2001). Together these findings suggest a global set of abnormalities matched by the functional abnormalities in cognitive, emotional, behavioral and social functioning.

EMOTIONAL NEGLECT IN EARLY CHILDHOOD: THE UNDER-EXPRESSION OF SOCIO-EMOTIONAL POTENTIAL

Clinical attention has been focused on extremes of neglect. The obvious clinical syndromes which result from pervasive neglect have facilitated research in this area. More recently, however, many researchers have observed and studied abnormalities in the capacity of children – and adults – to form healthy relationships. An emerging area of study is focusing on "attachment" – a special form of emotional bond. While usually not framed in context of developmental neglect, attachment problems in children often are the result of mistimed, abnormal or absent caregiving interactions and, therefore, may represent a special case of neglect. As with other brain-mediated capabilities, the capacity to form relationships results from

the experience-based expression of an underlying genetic potential to create the neural systems mediating socio-emotional behaviors.

At birth an infant has yet to form a true relational bond with another person. In most instances, the infant will be cared for by an attentive, attuned and loving caregiver. When this happens, a caregiver will, again and again, come to the hungry or cold or scared infant. Warming, soothing, feeding, cleaning and calming the infant, the caregiver creates a set of specific sensory stimuli which are translated into specific neural activations in areas of the developing brain destined to become responsible for socio-emotional communication and bonding. The somatosensory bath – the smells, sights, sounds, tastes and touch – of the loving caregiver provides the repetitive sensory cues necessary to express the genetic potential in this infant to form and maintain healthy relationships. This first and most primary of all relationships is this attachment bond.

The attachment bond has several key elements: (1) an attachment bond is an enduring emotional relationship with a specific person; (2) the relationship brings safety, comfort, soothing and pleasure; (3) loss or threat of loss of the person evokes intense distress. This special form of relationship is best characterized by the maternal-child relationship. The maternal-child attachment provides the working framework for all subsequent relationships that the child will develop. A solid and healthy attachment with a primary caregiver appears to be associated with a high probability of healthy relationships with others while poor attachment with the mother or primary caregiver appears to be associated with a host of emotional and behavioral problems later in life. More than 85% of children removed from their parents for abuse or neglect have disturbed attachment capacity, for example (Carlson *et al.*, 1989). The relationships between disordered attachment and increased risk for violent and aggressive behaviors are well documented (see Perry, 2001a).

THE MODERN WORLD AND NEGLECT OF SOCIO-EMOTIONAL GROWTH

Healthy attachment capacity is not enough to create healthy socio-emotional functioning. Attachment is only one form of the many kinds of relationships we form to create a healthy productive life. Certainly a securely attached child will have an easier time forming friendships, relationships with teachers, coaches, siblings and, over time, in the work place and larger community. As the brain organizes and develops in response to patterned, repetitive experience, the nature, timing, intensity and quality of an array of other relationships in the developing child's life will make a difference in the development of complex socio-emotional development. Yet without the opportunities to have friends, teachers, coaches, grandparents, neighbors, team mates and the many other kinds of relationships of childhood, these capabilities remain unexpressed. And if a child starts with attachment problems and has few opportunities to develop other relationships, they will have very poor or even pathological socio-emotional functioning.

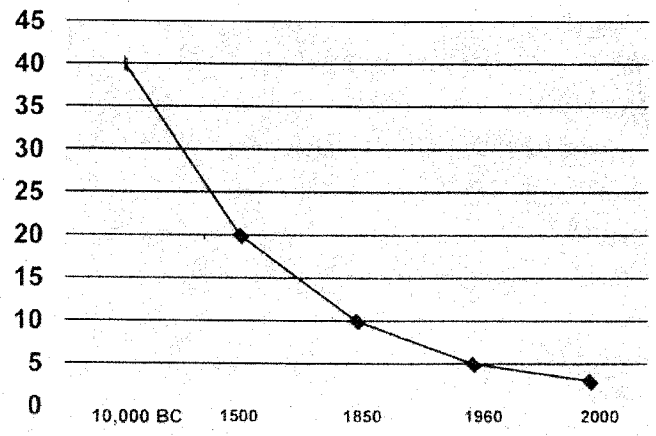

Figure 3. Decrease of number of persons living in a "household" in Western societies: From hunter-gatherer to the modern era. For more than 90 percent of human history we have lived in bands, clans or extended families of roughly 40 persons. In the West, by 1500 the average household had decreased to 20 persons; by 1850 to ten; in the United States to less than three persons in the average American household by 2000.

Our brain evolved over hundreds of thousands of generations in hominid and pre-hominid social groups. In these small hunter-gatherer bands a complex interactive dynamic socio-emotional environment provided the experiences for the developing child. At equilibrium in a group of fifty, there were three or more adult caregiving adults for every dependent child under age six. And there was little privacy. A dependent child grew up in the presence of the elderly, siblings, adults – related and not. There was a more continuous exposure and wider variety of socio-emotional interactions. The child in this situation had many opportunities to form relationships and, in a use-dependent way, develop the capacity to have a rich array of relationships. The genetic potential for healthy socio-emotional functioning – to be empathic, to share, to invest in the welfare of the community – is better expressed in children living in hunter-gatherer bands or extended families or close-knit communities in comparison with our compartmentalized modern world.

In this modern era, we separate from each other in many ways. The number of people we live with has shrunk (Figure 3); fewer than three people live in the average American household. And in our own homes, we have our own rooms. We rarely eat family meals. We spend thirty percent of our available time watching television – certainly not allowing for any use-dependent expression of an underlying genetic capacity for socio-emotional functioning. Our children are segregated with same age children for hours a day. In healthy homes the time a parent spends with older children is counted in minutes. We think a healthy ratio of adult caregiver to dependent child in our child care settings is one adult for five children – 1/16th the

ratio in a hunter-gatherer clan. We have over-scheduled our children and they have little time for spontaneous social play with peers.

The inadvertent effect of our modern advancements in lifestyle, communications, technology and economies is that we are now raising children in environments that are very different from the rich social context for which our brains are most suited. The effects of television and other electronic activities have significantly exacerbated this. Taking huge portions of the available day away from socio-emotional or other "human" activities, television ensures that new – and non-social – neural systems are being activated in comparison with humans raised one hundred years ago. The implications of this have yet to be fully understood although some indications suggest that we are losing "social capital." One indicator of this is the percentage of individuals who volunteer and vote. From 1972 to 2000, the percentage of young adults (age 18–24) voting in the Presidential election fell from 47% in 1972 to 27% in 1996 to 23% in 2000!

Summary and Future Directions

The many functions of the human brain result from a complex interplay between genetic potential and appropriately timed experiences. The neural systems responsible for mediating our cognitive, emotional, social and physiological functioning develop in childhood and, therefore, childhood experiences play a major role in shaping the functional capacity of these systems. When the necessary experiences are not provided at the optimal times, these neural systems do not develop in optimal ways.

Healthy development of the neural systems which allow optimal social and emotional functioning depends upon attentive, nurturing caregiving in infancy *and* opportunities to form and maintain a diversity of relationships with other children and adults throughout childhood. In our modern world, we are more mobile, compartmentalized and socially-disconnected. The true costs of our lifestyle choices may be difficult to see; yet an understanding of neurodevelopment suggests that the modern world's socio-emotional milieu is not sufficient for most children to express their true potential for forming and maintaining healthy relationships.

As a society, we value cognitive development and, therefore, provide consistent, repetitive and enriching cognitive experiences in the home and through our educational systems. In an age where more people must share increasingly limited resources, however, it is imperative that our children develop the capacity to share, be empathic and understanding of others. We must provide an investment in socio-emotional development comparable to our investment in cognitive development. The world, natural and manmade, now more than ever, needs the best of humankind.

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Finding Your ACE Score

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household **often or very often**...
   Swear at you, insult you, put you down, or humiliate you?
   or
   Act in a way that made you afraid that you might be physically hurt?
   Yes No If yes enter 1 _____

2. Did a parent or other adult in the household **often or very often**...
   Push, grab, slap, or throw something at you?
   or
   Ever hit you so hard that you had marks or were injured?
   Yes No If yes enter 1 _____

3. Did an adult or person at least 5 years older than you **ever**...
   Touch or fondle you or have you touch their body in a sexual way?
   or
   Attempt or actually have oral, anal, or vaginal intercourse with you?
   Yes No If yes enter 1 _____

4. Did you **often or very often** feel that ...
   No one in your family loved you or thought you were important or special?
   or
   Your family didn't look out for each other, feel close to each other, or support each other?
   Yes No If yes enter 1 _____

5. Did you **often or very often** feel that ...
   You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you?
   or
   Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?
   Yes No If yes enter 1 _____

6. Were your parents **ever** separated or divorced?
   Yes No If yes enter 1 _____

7. Was your mother or stepmother:
   Often or very often pushed, grabbed, slapped, or had something thrown at her?
   or
   Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard?
   or
   Ever repeatedly hit at least a few minutes or threatened with a gun or knife?
   Yes No If yes enter 1 _____

8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?
   Yes No If yes enter 1 _____

9. Was a household member depressed or mentally ill, or did a household member attempt suicide?
   Yes No If yes enter 1 _____

10. Did a household member go to prison?
    Yes No If yes enter 1 _____

Now add up your "Yes" answers: _____ This is your ACE Score.